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SERIOUS REDUCTION OF HAZARDOUS WASTE

For Pollution Prevention and Industrial Efficiency

CONGRESS OF THE UNITED STATES
Office of Technology Assessment
Washington, D. C. 20510

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Foreword

Americans are very concerned about hazardous waste. Opinion polls consistently show that the public worries more about hazardous waste than about any other environmental issue. We are constantly reminded of the loss of drinking water supplies from toxic waste contamination, the growing number of hazardous waste sites that must be cleaned up at great expense and with great difficulty, and that we must stop using land disposal for untreated wastes that remain harmful indefinitely.

OTA's first report on hazardous waste in 1983, *Technologies and Management Strategies for Hazardous Waste Control*, was used by Congress to examine the environmental problems and high long-term costs of land disposal practices and the benefits and availability of alternative waste treatment technologies. Congress made substantial use of that analysis in its 1984 amendments to the Resource Conservation and Recovery Act. In 1985 OTA's second hazardous waste report, *Superfund Strategy* examined the U.S. program to clean up uncontrolled hazardous waste sites. The report was an effort to shed new light on the scope of the problem and showed how—for environmental and economic reasons—permanently effective cleanup techniques based on waste treatment can replace leaving or redisposing Superfund wastes in the ground. The report also informed the public and assisted Congress in its deliberations on reauthorizing the Superfund program. Currently OTA is completing a study of Wastes in Marine Environments, including incineration in the open ocean.

Now Congress is turning its attention to preventing hazardous waste problems by cutting down on the generation of hazardous waste at its source through innovative engineering and management. The following committees requested the OTA study on waste reduction: Senate Labor and Human Resources, House Energy and Commerce, House Science and Technology, and House Small Business. But while everyone agrees in a philosophical sense that waste reduction is good, there is confusion about definitions and methods and, thus, about what is feasible. *Serious Reduction of Hazardous Waste* examines what is meant by hazardous waste, waste reduction, and even waste reduction technology. The report explores the meaning and consequences of giving primacy to waste *reduction* over waste *management*, and puts waste reduction squarely into the context of industrial production and efficiency, recognizing the current constraints of the American economy. The range of policy options examined is intended to assist what surely will be an extensive policy debate—similar in extent and importance to the energy efficiency debates of the past 15 years.

A broad range of perspectives and a great deal of information on waste reduction were obtained from the advisory panel, several workshop groups, respondents to a survey, and many others who provided information and assistance. OTA thanks them for their time and cooperation. Their participation, however, does not necessarily represent endorsement of the contents of the report, for which OTA bears sole responsibility.

John H. Gibbons

JOHN H. GIBBONS
Director

Serious Reduction of Hazardous Waste Advisory Panel

Frank L. Parker, *Chairman*
Vanderbilt University

Sandy Bihn
Administrator for the City of Oregon, Ohio

Lisa Bunin
Greenpeace

Joseph Chu
General Motors Corp.

Henry S. Cole
Clean Water Action Project/National Campaign Against Toxic Hazards

Peter S. Daley
Chemical Waste Management, Inc.

Dennis Drolet
Norchem, Inc.

Harry Fatkin
Polaroid Corp.

Ken Geiser
Tufts University

Phil D. Horelick
Allied Metal Finishing Corp.

Susan Johnnie
Hewlett Packard Corp.

James Lester
Colorado State University

Cindy McComas
Minnesota Technical Assistance Program

James Miller
Massachusetts Department of Environmental Management

Marian Mudar
New York State Environmental Facilities Corp.

M.L. (Mort) Mullins
Monsanto Corp.

James W. Patterson
Illinois Institute of Technology

David Roe
Environmental Defense Fund

David Sarokin
INFORM

Russell H. Susag
3M

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OTA Project Staff—Serious Reduction of Hazardous Waste

Lionel S. Johns, *Assistant Director, OTA*
Energy, Materials, and International Security Division

Audrey Buyrn, *Manager*
Industry, Technology, and Employment Program

Joel S. Hirschhorn, *Project Director*

Kirsten Oldenburg, *Assistant Project Director*

Martha Finnemore, *Research Analyst*

Edna Thompson, *Administrative Assistant*

Joyce Wills, *Secretary*

Elinor Horwitz, *Editor*

Contractors

David A. Allen
Gary A. Davis
Hampshire Research Associates
Michael Modell

OTA Workshop—Large Business Perspectives on Hazardous Waste Reduction

Jerry Berger
Shell Oil

Elliott Berkihiser
The Boeing Co.

Dick Constable
Sun Co.

Gary Crouth
Alcoa

David Gordon
Dow Corning

Khristine L. Hall
IBM

Edward J. Hessler
The Upjohn Co.

Susan Johnnie
Hewlett Packard Corp.

Andy Lampert
Diamond Shamrock Chemical

Martin B. MacInnis
GTE Products Corp.

Jerry B. Martin
Dow Chemical

Nick Odom
Springs Industries, Inc.

E.E. Sale
Exxon Chemical Americas

Norman Sealander
Northrop Corp.

Thomas Sliva
General Electric

Donald Smith
Polaroid Corp.

Steve Song
General Motors Corp.

Anthony Spinola
U.S. Steel Corp.

Russell H. Susag
3M

OTA Workshop—Small and Medium-Sized Business Perspectives on Hazardous Waste Reduction

David Anzures
California Technical Plating
California

Peter Bohlmann
Nordic Ware
Minneapolis

Harry DeSoi
Pioneer Metal Finishing
New Jersey

Dennis Drolet
Norchem
Illinois

Rudolph C. Gabel
Sybron Corp.
New York

Robert Hall
ESAB North America, Inc.
Colorado

Richard C. Herring
The Gloucester Co.
Massachusetts

Paul Hoffman
Garden Way, Inc.
New York

Phil Horelick
Allied Metal Finishing
Maryland

Jim Hornburg
The Dexter Corp.
New York

John McInerny
Cambridge Plating
Massachusetts

George McRae
Stanadyne, Inc.
North Carolina

Cort G. Platt
Precious Metals Platers
Minnesota

Russell Smith
Salsbury Laboratories
Iowa

OTA Workshop—State Activities in Waste Reduction

William C. Arble
Pennsylvania Technical Assistance Program

Susan Boyle
New Jersey Hazardous Waste Commission

Robert M. Confer
New Jersey Department of Environmental Protection

Lee Dane
Massachusetts Department of Environmental Management

Frederick L. Doll
Illinois Hazardous Waste Research and Information Center

A.J. Englande
Tulane University
Louisiana

Joseph M. Flynn
Connecticut Department of Economic Development

Rebecca Fricke (consultant)
Tennessee Department of Economic & Community Development

Gary E. Hunt
North Carolina Pollution Prevention Pays Program

Bob Laughlin
Ontario Research Foundation
Canada

Linda Little
Governor's Waste Management Board
North Carolina

Kate Quigley Lynch
Connecticut Hazardous Waste Management Service

Tom Lynch
New York Department of Environmental Conservation

Suzanne Mager
Massachusetts Department of Environmental Quality Engineering

Cindy McComas
Minnesota Technical Assistance Program

George Miller
University of Louisville
Kentucky

Marian Mudar
New York Environmental Facilities Corp.

Ruth Neff
Tennessee Safe Growth Team

Roger N. Schecter
North Carolina Pollution Prevention Pays Program

William M. Sloan
Maryland Hazardous Waste Facilities Siting Board

Benjamin Smith
Tennessee Safe Growth Team

Jim Solyst
National Governor's Association

T. Michael Taimi
Kentucky Department for Environmental Protection

Clifton J. Van Guilder
New York Department of Environmental Conservation

Valerie Wickstrom
Kentucky Natural Resources & Environmental Protection Cabinet

Harry Williams
Indiana Department of Environmental Management

Tom Yates
Tennessee Division of Solid Waste Management

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Richard C. Bird
Massachusetts Department of
Environmental Quality Engineering

Lee Dane
Massachusetts Department of
Environmental Management

Dana Duxbury
Tufts University

B.M. McDuff
DSH Association

Robert B. Pojasek
Chas. T. Main, Inc.

Margaret Rogers
The Society of the Plastics Industry

Roger N. Schecter
North Carolina Pollution Prevention Pays Program

Stuart H. Vaughn
Ford Motor Co.

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Chapter 1

Summary and Introduction

SUMMARY

Waste reduction is an economically sensible response to what many people see as a hazardous waste crisis. Several thousand pounds of hazardous waste are generated annually for every person in the Nation. Many thousands of people have lost their drinking water because of contamination by toxic waste. Across the country there are thousands of sites contaminated by hazardous waste that require billions of dollars for cleanup. An increasing number of lawsuits are being brought by people who claim to have suffered adverse health effects from living near toxic waste sites. Also the number of lawsuits being instituted by the government is mounting rapidly. These suits claim that certain waste generators have not complied with regulations and that generators who have used waste management facilities now on the Superfund list must pay for cleanups.

Waste reduction is critical to the prevention of future hazardous waste problems. By reducing the generation of waste, industry can use materials more efficiently and achieve more certain protection for health and the environment. At the same time, industry can lower waste management and regulatory compliance costs, liabilities, and risks.

Although there are many environmental and economic benefits to waste reduction, over 99 percent of Federal and State environmental spending is devoted to controlling pollution after waste is generated. Less than 1 percent is spent to reduce the generation of waste. The current level of national spending for pollution control is about $70 billion. Two-thirds of this is spent by industry. Since many hazardous substances are not yet regulated, annual expenditures will, in all likelihood, continue to increase.

OTA finds that reducing waste to prevent pollution from being generated at its source is now a practical way to complement this costly pollution control regulatory system. Because of sporadic and uneven enforcement, the current regulatory system weakens the incentive to reduce waste. Waste reduction, no matter how far it is taken, cannot eliminate all wastes, but it can help to lower costs for environmental protection as regulations continue to expand.

Definitions Used in This Report

Waste Reduction:

In-plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and environment. Actions taken away from the waste generating activity, including waste recycling or treatment of wastes after they are generated, are not considered waste reduction. Also, an action that merely concentrates the hazardous content of a waste to reduce waste volume or dilutes it to reduce degree of hazard is not considered waste reduction. This definition is meant to be consistent with the goal of preventing the generation of waste at its source rather than controlling, treating, or managing waste after its generation.

Hazardous Waste:

All nonproduct hazardous outputs from an industrial operation into all environmental media, even though they may be within permitted or licensed limits. This is much broader than the legal definition of hazardous solid waste in the Resource Conservation and Recovery Act, its amendments, and subsequent regulations. Hazardous refers to harm to human health or the environment and is broader than the term "toxic." For example, wastes that are hazardous because of their corrosivity, flamability, explosiveness, or infectiousness are not normally considered toxic.

Current pollution control methods often do little more than move waste around. For example: air and water pollution control devices typically generate solid, hazardous waste that goes to landfills and too often leaches from there into groundwater. Many hazardous wastes, such as most toxic air emissions, are not yet regulated, and regulatory standards for permissible emissions legally sanction the generation of some wastes. Thus, **OTA finds that establishing a comprehensive, multimedia approach to reducing wastes going into the air, land, and water is essential.**

OTA finds that there is no common definition of waste reduction; there are few or no data on the extent of industrial waste reduction; waste reduction is usually measured incorrectly; and the information that the government collects on waste generation is not useful for waste reduction. If waste reduction is defined to include waste treatment, companies will naturally pay more attention to treatment, which is a familiar activity, than to the reduction of waste. **Problems of definition and lack of information should be addressed and ongoing waste reduction efforts should be documented by government, even if decisions to reduce waste remain at the discretion of individual companies.**

Despite some claims to the contrary, industry has not taken advantage of all effective waste reduction opportunities that are available. Reducing waste involves more than buying a black box, reading the directions, and plugging it in. Even a simple step toward waste reduction can seem difficult to a company with few technical resources and no obvious place to go for guidance. Reducing waste in an industrial process requires intimate knowledge of all aspects of that specific production process, in contrast to waste treatment, which is essentially an add-on to the end of the process. There are also clear pressures to reduce waste tomorrow, rather than today. **The attention and resources given to required pollution control activities limit the amount of thought, time, and money that industry can devote to waste reduction.** Some U.S. companies, however, have verified the fact that waste reduction pays for itself relatively quickly, especially when compared to the time needed to comply with regulations, obtain regulatory permits, or site waste management facilities. Some companies are even beginning to sell new products and services that help others to reduce waste.

Waste reduction succeeds when it is part of the everyday consciousness of all workers and managers involved with production—where the waste reduction opportunities are—rather than when it is a job only of those responsible for complying with environmental regulations. A few people with end-of-pipe, pollution control jobs are not in a position to reduce waste by themselves; such efforts must involve upstream workers and facilities.

There are five approaches that industry can take to reduce hazardous waste: 1) change the raw materials of production, 2) change production technology and equipment, 3) improve production operations and procedures, 4) recycle waste within the plant, and 5) redesign or reformulate end-products. Among the opportunities that exist for common processes and wastes are: 1) using mechanical techniques rather than toxic organic solvents to clean metal surfaces, 2) using water-based raw materials instead of materials based on organic solvents, and 3) changing plant practices to generate less hazardous wastewater.

So far government has not required waste reduction. **OTA finds that it would be extraordinarily difficult for government to set and enforce waste reduction standards for a myriad of industrial processes.** The impact on industry, particularly on troubled manufacturing sectors, could be substantial. Alternatively, the United States could move to an economically sensible environmental protection strategy based on *both pollution control* (waste management) *and pollution prevention* (waste reduction) with the Federal Government providing leadership and assistance in the following ways.

First, through policy development, education, and oversight, Congress could help industry and the Nation profit from seeing waste reduction not as some unique technology, but as a field ready for innovative engineering and management. These opportunities are embedded in every part of the industrial production system. There is no way to predetermine the amount of waste reduction that is possible; its technical and economic feasibility depend on the characteristics, circumstances, and goals of specific waste generators. Success in reducing waste depends on the ability of organizations to modernize, innovate, and cut costs, thereby increasing profits and reducing long-term liabilities. Thus waste reduction could be used as a measure of performance as energy efficiency and productivity often are.

Second, there are a number of possible legislative actions that could clarify the definition of waste reduction, spur better collection of information on waste reduction, and encourage waste generators to devote more attention to the subject. If the Federal public policy goal is rapid and comprehensive hazardous waste reduction, then a strategy based on government leadership and assistance rather than on prescriptive requirements is likely to be the most effective. For example, Congress could: 1) create an Office of Waste Reduction with an Assistant Administrator within EPA, 2) create a grants program to develop generic or widely transferable technical support for waste reduction, 3) through new comprehensive waste reduction legislation require detailed reporting by industry on past waste reduction actions and plans for future efforts, 4) reward and facilitate waste reduction by offering industry concessions from existing pollution control regulatory requirements, or 5) create and use independent State Waste Reduction Boards to implement programs. Setting a national waste reduction goal of perhaps 10 percent annually could help convert the long stated importance of waste reduction into a true priority and reduce annual environmental spending substantially, ultimately by billions of dollars.

BACKGROUND

Currently, American environmental protection efforts emphasize control and cleanup of pollution by hazardous substances *after* they are generated and no longer serve a productive function. Virtually all industries, whether high technology, smokestack, or small shops, generate hazardous waste. The cost of controlling that waste totals many billions of dollars annually. Usually, hazardous industrial wastes are not destroyed by pollution control methods. Rather, they are put into the land, water, or air where they disperse and migrate. The result is that **pollution control for one environmental medium can mean that waste is transferred to another medium.**

As the costs of administering environmental programs and the costs of compliance mount, the economic and environmental benefits of reducing the generation of hazardous waste at its source have become more compelling. But it is exactly these regulatory requirements and the costs of complying with them that both encourage *some* waste reduction and make it difficult for industry to give waste reduction the priority and resources it deserves for near-term wide-scale implementation. **Although current costs for pollution control serve as an indirect incentive for waste reduction, it is not certain that: 1) an incentive exists for all firms, or for the most appropriate people or departments within a company; 2) all or most waste generators have the technical and economic resources to respond to that incentive; 3) the incentive is**

Waste Reduction and National Policy

"The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment."

From the *Resource Conservation and Recovery Act*, as amended by the U.S. Congress in November 1984. This policy statement is supported by *waste minimization* provisions also added to the act.

consistently supported by congressional and regulatory actions; or 4) that waste reduction will be the response.

In practice, waste reduction is frequently subordinated to pollution control, even though reducing waste can be the most effective way to prevent environmental risk. The domination of pollution control over waste reduction is not new; it has occurred over many years and it will not be reversed overnight.

Federal law *says* that waste reduction is the preferred anti-pollution method; but government *actions* often send a different—or ambiguous—message to waste generators.

Federal and State actions, however, are not the sole determinants of how much waste is reduced. Frequently, inadequate information makes it difficult for waste generators to assess the benefits of a one-time, near-term investment for waste reduction versus *repeated* spending and ongoing liabilities over the long term for waste management. Pollution control measures are more familiar and thus more certain. Uncertainty also arises because waste reduction, as a measure of materials productivity, is subordinated to other measures of the efficiency of industrial operations, such as labor productivity and energy consumption.

As a result, waste reduction, which saves money for industry and protects the environment, is being implemented in an uneven and largely undocumented fashion. Assessing the economics of waste reduction poses problems. For some people a major focus on waste reduction raises concerns that it might, through the costs of implementation, contribute to what is called the "deindustrialization" of America. However, **those who have implemented waste reduction effectively generally see it as a way to improve profitability and competitiveness.** If waste reduction were to be carefully promoted and become more widespread—and virtually everyone believes this is possible—environmental and economic benefits would increase. Statistical documentation of the amount of waste reduction that has already occurred nationwide and a summary of its results would almost certainly remove the uncertainty that some representatives of industry and government have about the near-term feasibility of waste reduction.

OBJECTIVES OF THIS STUDY

The purpose of this study is to provide Congress with a concise base of information and analysis to assist it in ensuring implementation of its declared national policy of reducing the generation of hazardous waste. More specifically, OTA defined the following study objectives.

1. *To explore the context for concern about waste reduction.* What is the significance of reducing the generation of all hazardous industrial waste rather than only those regulated as solid, hazardous waste under the Resource Conservation and Recovery Act (RCRA)? Why is waste reduction important? An initial task in this exploration was to adopt precise definitions of "hazardous waste" and "waste reduction."
2. *To examine the technological nature of waste reduction and the extent to which waste reduction has been and is likely to be implemented by industry.* To what extent is technology itself rather than information and resources a barrier to waste reduction? In what ways are waste reduction decisions dependent on the unique circumstances of a specific company or industry? Can the amount of feasible waste reduction be estimated? How much can research increase the feasible amount of waste reduction? (Note that only the policy aspects of this report deal solely with industrial waste generation, but all other discussions apply to nonindustrial waste reduction as well.)
3. *To analyze Federal programs that directly or indirectly affect industrial waste reduction.* Is the Federal Government playing a significant positive or negative role in as-

suring that waste reduction becomes more commonly adopted by American industry?

4. *To examine State programs that have been established to reduce industrial waste.* What is the extent and effect of State programs? Do State programs remove the need for Federal initiatives?
5. *To define and analyze a broad range of policy options that might help the Nation implement current national waste reduction policy without causing harm to American industry.* Is there a need for Federal initiatives and, if so, what are they? What are the advantages and disadvantages of implementing waste reduction?

PREVENTION AND CONTROL OF POLLUTION: THE PRIMACY OF WASTE REDUCTION

The national debate on the environment is beginning to move away from traditional discussions about how to make pollution control regulations effective. A more fundamental question is now being posed: *How can pollution prevention be used to complement pollution control?* Some years ago, Dr. Joseph T. Ling of 3M articulated the case for pollution prevention:

> Pollution controls solve no problem; they only alter the problem, shifting it from one form to another, contrary to this immutable law of nature: the form of matter may be changed, but matter does not disappear . . . [I]t is apparent that conventional controls, at some point, create more pollution than they remove and consume resources out of proportion to the benefits derived . . . What emerges is an environmental paradox. It takes resources to remove pollution; pollution removal generates residue; it takes more resources to dispose of this residue and disposal of residue also produces pollution.[1]

More recently, 3M summed up its unrelenting pollution prevention efforts since 1975:

> The combined total of almost 1,900 projects has resulted in eliminating *annually* the discharge of almost 110,000 tons of air pollutants, over 13,000 tons of water pollutants, and over 260,000 tons of sludge of which over 18,000 tons are hazardous—along with the prevention of approximately 1.6 billion gallons of wastewater. Cost savings to 3M total more than $292 million. These costs are for pollution control facilities that did not have to be built; for reduced pollution control operating costs; for reduced manufacturing costs; and for retained sales of products that might have been taken off the market as environmentally unacceptable.[2]

Reduction—applied to a broad universe of emissions, discharges, and wastes—is the best means of achieving pollution prevention. However, developing a *complementary* environmental protection strategy, based on waste reduction, represents a major shift in thinking. Because we now have an entrenched pollution control culture, this shift would be a substantial challenge for industry and government. **But no matter how strongly waste reduction is implemented, pollution control regulations will always be needed for wastes that cannot be or have not yet been reduced.**

The traditional emphasis on pollution control and the prevalent viewpoint that substantial waste reduction is a long-term goal, not a realizable short-term strategy, constrain the consideration of alternatives by waste generators. (Paradoxically, the claim is also heard that all waste reducing measures that can be taken *have* been taken; i.e., that waste reduction is a used-up strategy.) One inhibiting factor is concern about risking product quality by tinkering with or changing processes solely for the purpose of reducing waste.

For companies and industries that are expanding production, waste reduction is an obvious way to offset the economic and environmental costs of managing increasing amounts of wastes. Waste reduction also addresses concerns about the economic inefficiency of increasing pollution control regulations; that is, spending more and more for smaller increments in environmental protection. Whatever their environmental benefits, experience shows that the development and implementation of pollution control regulations takes considerable effort, time, and money on the part of industry and government.

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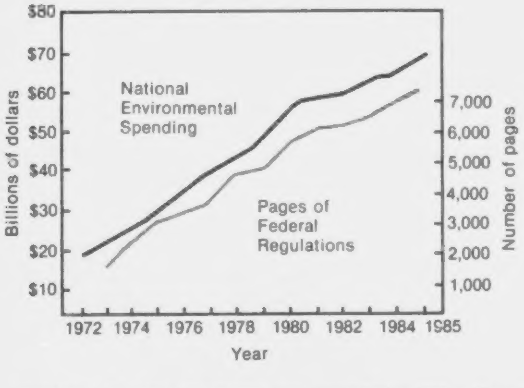
[1] Michael G. Royston, *Pollution Prevention Pays* (New York: Pergamon Press, 1979), p. xi. For a full articulation of the pollution prevention strategy, this book is considered the seminal work.

[2] M.D. Koenigsberger, 3M, paper presented at *Governor's Conference on Pollution Prevention Pays*, Nashville, TN, March 1986.

Figure 1-1 illustrates how steadily increasing environmental regulations have been paralleled by a growth in environmental spending by the Nation. There are many factors that determine the extent of national spending to protect the environment, including how much waste is generated, exactly what the regulations call for, and how these regulations are enforced. But it is also apparent that over the past 14 years the simple size of the body of Federal regulations has been a fairly reliable proxy for the many substantive factors that determine spending. Over that period spending has been about $10 million for every page of Federal environmental statute and regulation. In 1985 $70 billion was spent nationally and there were 7,000 pages of Federal environmental statutes and regulations. **Two solutions present themselves for reducing national spending on the environment: government can change regulations—for example, by redefining hazardous waste, or by cutting regulations and/or limiting their enforcement—or generators can reduce wastes.** The latter approach is clearly more desirable; waste reduction has already been demonstrated to have the capability—for some waste generators—of turning the spending curve down as regulations continue to increase.

Figure 1-1.—Current Regulations: An Economic Incentive for Waste Reduction



SOURCES: L.B. Cahill, *The Weston Way*, Winter/Spring 1986 p. 26; and U.S. Department of Commerce and Management Information Services, 1985.

But decreasing environmental spending nationwide through waste reduction can occur only if Federal statutes and regulations were to unequivocally establish the primacy of waste reduction (that is, of pollution prevention) over waste management. From the generator's perspective, waste reduction is an alternative that reduces the costs of regulatory compliance and that reduces the potential for enormous costs of later litigation. From the government's viewpoint, waste reduction does not sacrifice the integrity or environmental protection goals of pollution control regulations. **Asserting the primacy and economic importance of waste reduction does not necessarily mean that government must then prescribe and regulate the amount of waste reduction generators must accomplish. Nor does it imply that waste reduction can ever eliminate all wastes or the need for all pollution control regulations.** The meaning, case for, and implications of the primacy of waste reduction are discussed below.

What Is Waste Reduction?

The term *waste reduction* means different things to different people. Arriving at a definition of waste reduction is not a trivial pursuit. One study of waste reduction pointed out that the "difficulties and differences in definition . . . themselves constitute one of the factors affecting industry's decisions about the generation of hazardous waste."[3] **The definition of waste reduction also affects the design, implementation, and effectiveness of government actions.**

Box 1-A summarizes the problems that arise from several characteristics of commonly used definitions of waste reduction and similar

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[3] National Research Council, *Reducing Hazardous Waste Generation* (Washington, DC: National Academy Press, 1985), p. 9.

Box 1-A.—Problems With Definitions of Waste Reduction and Similar Terms

Problem #1

Several terms currently are used to describe preferred methods of dealing with hazardous waste. These terms include:

waste reduction	waste prevention
waste minimization	waste avoidance
waste abatement	waste elimination

source reduction

No standard definitions exist for any of these terms. Each is defined differently by each user.

Problem #2

Definitions include **pollution control** activities as well as pollution prevention activities. Among these are:

- out-of-process recycling;
- offsite recycling;
- onsite or offsite treatment, such as incineration; and
- weight or volume reduction with a corresponding increase in concentration of hazardous content.

The distinction between preventing waste from being generated and controlling waste after it is generated is blurred when pollution control actions are included in the definition of waste reduction and similar terms. Consequently:

- the primacy of pollution prevention is eroded,
- generators are not encouraged to consider pollution preventing activities because pollution control options are given equal standing,
- risks to health and the environment from transport and handling of waste are not explicitly weighed, and
- measurements of reduction of waste generation are obscured by including the results of pollution control.

Problem #3

Definitions do not apply to all hazardous wastes. Most definitions apply reduction only to some combination of the following:

- RCRA-regulated wastes (wastes regulated under Clean Water and Clean Air are excluded);
- toxic wastes (hazardous, but nontoxic wastes are excluded); or
- regulated wastes (hazardous, nonregulated wastes such as most toxic air emissions are excluded).

terms. The most serious problem is that any definition that includes waste management, including waste treatment and recycling away from the production site, will probably divert attention away from the goal of waste reduction. **The broadly accepted goal of minimizing the amount of hazardous waste put into the land should not obscure the even more fundamental goal of reducing the generation of hazardous waste.**

A number of definitions of waste reduction used by States and in studies include all waste recycling or waste treatment or both. For example, it is widely assumed that Federal statutes and regulations use the term *waste minimization* to include, along with waste reduction, preferred waste management activities that reduce the amount of waste to be land disposed. Thus, the Federal statute and regulations that allow generators to use their own definition also allow them to comply by improving waste management; there is no clear message that waste reduction is preferred, or that it should be considered first. **If waste reduction does indeed have primacy, then it must be defined and used in a way that allows no misunderstanding of what either waste reduction or primacy means**. Otherwise, better waste management could easily sap resources that might go to waste reduction. **Preferred waste management measures can and should stand on their own merits, rather than being considered a part of waste reduction.**

OTA has adopted a definition that addresses these shortcomings and is technically sound, consistent with the current congressional statement of national policy, and useful for discussing policy options. *It also reflects the importance for public policy development of defining waste reduction in a way that is consistent with the concept of pollution prevention.* OTA's definition is:

> **Waste reduction refers to in-plant practices that reduce, avoid, or eliminate the generation of hazardous waste so as to reduce risks to health and environment.**

The focus, therefore, is on what occurs at the source of generation. The goal of waste reduction is to alter current practice and to design future industrial processes and operations in a way that will reduce the degree of hazard of waste and the amount to be managed, controlled, and regulated. A recent study concluded: "[i]n-plant options are probably the most effective and economical means of managing hazardous wastes."[4]

The OTA definition addresses "what," "where," and "by whom" questions without specifying "how" waste reduction is to be carried out. An important consequence of this definition is that **various means of reducing waste, which are applied *after* the waste is generated outside of the location where waste is generated, are characterized as a form of waste *management*.**

Some difficulties in interpretation still occur, particularly in relation to waste recycling. **When recycling is environmentally acceptable and is an integral part of the waste generating industrial process or operation OTA considers it waste reduction.** An example is a closed-loop application which returns (potential) waste as it is generated for reuse within the process. To the extent that in-process recycling prevents transfer of hazardous material into the environment, it is waste reduction.

But recycling is *not* considered waste reduction if waste exits a process, exists as a separate entity, undergoes significant handling, and is transported from the waste generating location to another production site (perhaps a part of a large plant) for reuse, or to an offsite commercial recycling facility or waste exchange. This distinction does not mean that such waste *management* is unacceptable, unreasonable, or improper. On the contrary, as will be discussed in detail later, offsite recycling is a preferred waste management alternative. There can be valid reasons why such a waste management method is technically or economically justified for a specific industrial operation, such as for many generators of small quantities of hazardous waste.

But even recycling facilities pose risks. RCRA regulation of such facilities are to some extent a disincentive for recycling. This issue has received considerable attention. The distinction made here between in-process recycling that is a part of the waste generating activity and all other types of recycling may be a practical way to resolve that issue. If in-process recycling were regulated, that would indeed serve as a disincentive for its use; current RCRA regulations may or may not cover in-process recycling depending on how they are interpreted (see ch. 5).

What Is Hazardous Waste?

Although toxic wastes are of major concern today, there is no reason why the concept of waste reduction must be restricted to toxics.

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[4] Michael R. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986), p. 2.

OTA's definition of hazardous waste in this report is:

> **Hazardous waste refers to all nonproduct hazardous outputs from an industrial operation into all environmental media, even though they may be within permitted or licensed limits.**

This definition is much broader than that of hazardous waste under RCRA and is also more inclusive than the term *hazardous substances*, as used in the Federal Superfund program. Thus, this report covers a broad universe of hazardous substances and pollutants (toxic and conventional) that industry generates, discharges, and emits routinely or accidentally.[5] **It is OTA's position that all hazardous wastes are amenable to waste reduction although the exact circumstances of a generator may not support reducing a particular waste. No technical case can be made for the notion that some wastes can be reduced and others cannot.**

Current environmental statutes, programs, and regulations may not cover all hazardous waste. Many wastes are covered by only some of the current regulations that separately control or manage disposal practices for the land, air, and water. For instance, RCRA hazardous wastes include toxic, ignitable, corrosive, and reactive substances. The Clean Air Act serves as the basis for regulating both criteria pollutants (such as ozone, particulates, sulfur oxides, carbon monoxide, nitrogen oxides, and lead) and hazardous air pollutants (often referred to as air toxics). Discharges into the Nation's waters are covered by the Clean Water Act and controlled by regulating both conventional (biochemical oxygen demand, fecal coliform, total suspended solids, oil/grease, and pH) and toxic or priority pollutants. (The various statutory and regulatory definitions of the preceding terms are given in chapter 5.)

OTA has concluded that a comprehensive, multimedia (air, water, land) definition for hazardous waste is necessary. The two chief reasons for this conclusion are: 1) to avoid creating opportunities for shifting waste from one environmental medium to another possibly unregulated or less regulated medium, such as has happened for some wastes that are land disposed rather than being discharged into waterways; and 2) to include wastes that are not currently regulated, such as most toxic air emissions. If the term *hazardous waste* is defined or applied narrowly, waste reduction measures can be ineffective.[6] The situation regarding trichloroethylene (box 1-B) is a vivid, but not necessarily typical, example of a widely used product almost all of which emerges from industrial processes as an unregulated hazardous waste. If only a RCRA definition is given to hazardous waste, nearly 90 percent of trichloroethylene waste that goes into the air and water will not be covered. A very different example is cadmium waste. In this instance 80 percent of the waste is land disposed and regulated under RCRA, 12 percent is emitted into the air, and 8 percent goes into surface water.[7]

Public and Private Roles

Historically, Federal policy has not *directly* promoted waste reduction as a method of environmental protection. The extent of State government efforts on waste reduction dwarfs Federal ones, even though, as will be discussed later, State efforts are also limited. However, Federal regulatory programs have provided some indirect economic incentives for waste reduction by increasing the cost of compliance with waste management regulations as well as increasing insurance costs and costs of clean-

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[5] With regard to the concept of "hazardous," the following definition of a hazardous material adopted by the California Department of Health Services is useful: a substance or combination of substances which, because of its quantity, concentration, or physical, chemical, or infectious characteristics, may either: 1) cause, or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or 2) pose a substantial present or potential hazard to human health or environment when improperly treated, stored, transported or disposed of or otherwise managed.

[6] It is, of course, better to have some waste reduction than none. Yet when reduction is limited, important and environmentally threatening wastes may receive no attention. For example, Du Pont, which has initiated a major waste reduction program and has already achieved considerable success, does not include air emissions and wastewaters discharged through permitted outfalls; and non-RCRA wastes are not always included. [*Waste Reduction: The Ongoing Saga*, proceedings of a Tufts University Center for Environmental Management conference, Woods Hole, MA, June 1986.]

[7] U.S. Environmental Protection Agency, "Cadmium Contamination of the Environment: An Assessment of Nationwide Risk," February 1985.

Box 1-B.—Waste Generation From Production and Use of Trichloroethylene

Type of Material.—Trichloroethylene (TCE) is a volatile halogenated organic chemical used widely as a solvent. It is known to be toxic to the liver and nervous system and is now considered a probable human carcinogen.

Production.—In 1983, 65,700 metric tons were produced by two companies; one plant is in Texas, the other in Louisiana. Only about 100 tons (0.2 percent) were emitted to the atmosphere from production itself and only another 39 metric tons from the distribution network. Production has been decreasing since it peaked at 277,000 metric tons in 1970. This has been occurring, in part, because of the substitution of other solvents, such as methyl chloroform and perchloroethylene, which themselves may pose hazards.

Uses and Waste Generation.—*About 90 percent of TCE used becomes a hazardous waste.* In 1983, 85 percent (56,000 metric tons) of all TCE produced was used as a solvent for cleaning and degreasing operations in many thousands of plants nationwide; 52,600 metric tons were emitted to the atmosphere (94 percent). The second major use is in manufacture of polyvinylchloride (PVC); of the 6,500 metric tons used in this way about 130 metric tons (2 percent) are emitted to the atmosphere, with almost all of it consumed in the chemical reaction. Essentially all of remaining usage is assumed to be emitted to the atmosphere.

Waste Management Media Transfer.—Release of TCE into the environment (for 1978) has been estimated to be: 86 percent into the air, 12 percent into the land, and 2 percent into water. Much of what goes into the land and water can volatilize. From volatilization of industrial aqueous discharges sent to publicly owned treatment works (POTWs) roughly 1,400 metric tons were released to the atmosphere in 1983; this is about 10 times the amount of waste from production and distribution of TCE. An EPA analysis of wastes to POTWs indicates that two-thirds of the input TCE (1,729 metric tons) is emitted into the air, 5 percent goes into surface water, 5 percent goes into sludge, and 23 percent is destroyed by biodegradation. Other than by natural degradation in the atmosphere, only about 0.7 percent of TCE waste is destroyed through treatment.

Presence at Superfund Sites.—Found by EPA to be the most frequently occurring substance overall (at 179 of 546 sites); number one for groundwater, third in surface water, and fifth in the air.

Regulation.—Although TCE as a waste exists predominantly as an air pollutant, EPA has only recently given notice of intent to list TCE as a hazardous air pollutant under Section 112 of the Clean Air Act (March 1986). TCE is regulated under RCRA as a solid, hazardous waste and is considered a hazardous substance under CERCLA (Superfund). As one of 126 priority toxic pollutants, TCE is also regulated under the Clean Water Act. Under the Safe Drinking Water Act, the Recommended Maximum Containment Level is zero in drinking water, and the Maximum Contaminant Level (enforceable standard) in drinking water is 0.005 mg/l. Under the Occupational Safety and Health Act, the 8 hour time weighted average exposure limit for a 40 hour week is 100 ppm, with an acceptable ceiling concentration of 200 ppm.

SOURCES: U.S. Environmental Protection Agency, "Survey of Trichloroethylene Emission Sources," July 1985; U.S. Environmental Protection Agency, "Intermedia Priority Pollutant Guidance Document: Chlorinated Solvents," October 1984; U.S. Environmental Protection Agency, *Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works*, February 1986.

ing up toxic waste sites. These indirect incentives have been particularly effective for *some* waste generators and for *some* wastes.

However, this effectiveness is weakened by poor and uneven enforcement of regulatory programs and by markedly different levels of regulation for specific wastes. **By relying solely on indirect incentives, the government presumes that a company is motivated to implement waste reduction techniques and that it has the technical and economic resources to do so.**

In the private sector, successful waste reduction efforts have generally been a consequence of attempts to increase the efficiency of industrial operations. **Waste represents inefficiency and it is indisputable that industry reduces some hazardous waste, since to reduce waste is to conserve materials that may be scarce, strategic, or expensive.** Most commonly, waste reduction has been a byproduct, not a focus, of altered industrial processes since waste management costs have rarely been so high as to suggest alternatives. At some point, continued efforts to improve the yield of industrial processes by maximizing product output relative to input of raw materials will not appear economically attractive because the amounts of product increases will be small.

Yet reducing waste generation may, in its own right, be significant today because of rising waste management costs, anticipated long-term liabilities, and environmental risks. But these may not be factored into decisions made by generators, especially if the focus is on product yield rather than on waste reduction. Accounting methods that do not assign the full short- and long-term costs of waste generation to production profit centers can further obscure the economic considerations that should be available to decisionmakers if wise choices are to be made. **OTA believes that although some success has been achieved for waste reduction by American industry, more can be accomplished and that waste reduction represents a primary, economically viable means of hazardous waste control** (see box 1-C).

Waste reduction has traditionally been the prerogative of industry and even now industry and government generally see it as a *voluntary* practice. However, consider the following policy statement that was added to RCRA in 1984:

> The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible.

The second sentence of this statement concludes that:

> Waste nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

Box 1-C.—Ways Companies Can Promote Waste Reduction

- **Conduct a waste reduction audit** to provide information about: 1) types, amounts, and level of hazard of wastes generated; 2) sources of those wastes within the production operation; and 3) feasible reduction techniques for those wastes.
- **Revise accounting methods** so that both short- and long-term costs of managing wastes, *including* liabilities, are charged to the departments and individuals responsible for the processes and operations that generate the waste.
- **Involve all employees** in waste reduction planning and implementation. Waste reduction must be seen as the responsibility of all workers and managers involved in production, rather than just the responsibility of those who deal with pollution control and compliance.
- **Motivate employees** and focus attention on waste reduction by setting goals and rewarding employees' suggestions that lead to successful waste reduction. Special education and training can help all types of employees identify waste reduction opportunities at all levels of operation and production.
- **Transfer knowledge throughout the company** so that waste reducing techniques implemented in one part of the company can benefit all divisions and plants. This is particularly important in large companies. Newsletters and company meetings can be helpful tools for disseminating information about waste reduction opportunities.
- **Seek technical assistance** from outside sources. This may be particularly useful for smaller companies with limited technical resources. Sources of outside assistance include State programs, universities, and professional consultants.

This policy statement implies that waste reduction has primacy over waste management. The lack of a direct mention of *economic* feasibility or practicality makes the statement especially strong. But policy is not clear, because the RCRA statutory term *waste minimization* is interpreted by many people to give equal footing to preferred waste management. It is not entirely clear whether this government policy states that a decision to use a preferred form of waste management should occur only **after** a thorough exploration of the feasibility of waste reduction.

A summary of the problems associated with those 1984 RCRA Amendments that deal with waste reduction and minimization, the regulations based on these amendments, and their implementation by EPA and the States is given in table 1-1. For the most part, the 1984 congressional action does not alter the voluntary character of industrial waste reduction. Its significance is that it has raised the level of importance of waste reduction in the eyes of industry decisionmakers. **A major policy issue facing the Federal Government is whether it should become *directly* involved in stimulating or even requiring waste reduction.**

It is important to be aware, however, of ways in which government actions could be harmful to U.S. industry. For example, **some types of mandatory waste reduction regulations with enforced penalties for noncompliance could harm international competitiveness for some industries and products because they are too inflexible, are inattentive to site-specific constraints, or ignore capital investment needs.** High costs for implementation not born by competitors and standards applied equally across U.S. industry could have grave consequences for troubled manufacturing sectors.

On the positive side, over 80 percent of 99 small, medium, and large companies surveyed by OTA[6] believe that employment would either increase or not be affected by stepped-up but not necessarily mandated waste reduction efforts. Increasing waste reduction also will help reduce the presence of toxic chemicals everywhere, an environmental benefit that is often cited. Waste reduction would result in lower worker exposure to toxic chemicals, fewer transportation accidents involving hazardous substances, and fewer hazardous consumer products. **Increasing numbers of successful examples of waste reduction yielding net cost savings and more competitive operations support the argument that waste reduction promotes industrial revitalization and economic growth.** For all these reasons ample justification, going well beyond environmental imperatives, can be cited for a strong Federal role in waste reduction. (Although discussions of public roles usually focus on Federal and State government, it should be noted that local governments are increasingly encouraging more waste reduction by local companies.)

In the private sector, the interests and actions of several groups must be considered:

1. the insurance industry may require plans and commitments for waste reduction as a condition for obtaining pollution liability insurance, which is now difficult and costly to obtain;
2. financial institutions may use waste reduction plans and performance as criteria to judge the merits of borrowers; if they view investments for waste reduction in the same way as they view traditional investments for expansion and modernization, then waste reduction efforts will be aided;
3. some environmental organizations and public interest groups are now making waste reduction a high-priority issue and are educating the public about its importance as well as trying to influence government and industry decisions and programs; and
4. various organizations offer seminars, short courses, and conferences, which bring attention to waste reduction and transfer technical information to people in industry.

Although it has not been possible for this study to examine in detail the potential impact of these embryonic private sector efforts, it is evident that they are destined to play an important role in stimulating industrial waste reduction nationwide. The role of the news media is less certain. There is already evidence

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[6] Here and in similar subsequent statements about industry's viewpoints, reference is being made to the results of an OTA survey of industry people directly involved with waste management and reduction (see app. A).

Table 1-1.—1984 Amendments to RCRA on Waste Minimization (WM): Problems in the Statute, Regulations, and Implementation

		Implementation	
The statute	Regulations	By EPA	By States
1. Policy and administration Primacy of waste reduction made clear by strong *national policy* outlining a two-tier approach: pollution prevention (waste reduction) and pollution control (preferred waste management practices) to minimize risk. No economic test to limit activities.	National policy was not restated in preamble.	EPA views WM as minor component of land disposal bans. Little oversight of implementation by EPA HQ; no WM budget commitment. EPA assumes States are handling implementation of regulations even though EPA is required to do so until States are authorized.	States not responsible for implementation until authorized.
2. Definitions and measurement Ambiguous phrasing in implementation sections. WM can be interpreted as either: 1) reducing the generation of waste (prevention), or 2) reducing waste that is generated (control). This definition erodes primacy of waste reduction and causes uncertainty in measurement. Economic/technological limits placed on required WM activities: "economically practical" waste reduction and "practical available" waste management.	Primacy of waste reduction eroded by ambiguous phrasing carried over into regulations. Waste minimization, waste reduction, waste management are not defined; results in high uncertainty among regulators and generators as to what constitutes WM.	EPA did not supplement statutory/regulatory language by issuing broad guidelines as to what constitutes WM or how it should be measured. Other actions/statements by EPA imply WM is any activity that will reduce wastes *before* or *after* generated.	States use different definitions, with focus usually on preferred waste management to reduce need for land disposal facilities.
3. Required actions *Implementation sections* mandate three actions: 1) WM certification on manifests, 2) WM activities/results statement added to biennial report, and 3) annual WM statement by generators managing wastes onsite. Each action as written includes waste reduction and preferred waste management components; however, primacy of waste reduction over preferred waste management not clear. Having WM program in place is not a required activity for biennial reporting.	*1) Manifest certification* Only generators who ship wastes offsite must sign WM certification statement on new manifest form.	No leadership from EPA	States generally picked up use of new manifest with WM certification or adopted language for own manifest.
	2) Biennial report Only generators who ship wastes offsite (subset of Nation's total generation) required to report WM activities in biennial reporting. No reporting guidelines issued with regulations.	Reports covering waste generation in 1985 due March 1, 1986. Little guidance given to generators/States on what constitutes a WM program. Form required only narrative statement. Results: 1) no data likely to be collected, or 2) no consistency in reporting. Little followup evaluation will be possible on effectiveness of regulations.	Most States collected what information assumed required. A few asked generators to supply supplemental information. Information remains at State level; EPA did not request submission of WM information in required biennial report summary.
	3) Permit condition Generators who treat, store, dispose of wastes onsite subject to TSDF permits. Permits now require annual statement on WM program to be placed in operating file onsite. No details required.	Lack of definition/guidelines has created variability among regions. Regions/generators unsure about what constitutes a WM program statement.	WM condition of permit primarily handled by EPA regions rather than States.
4. Enforcement Enforcement not mandated. Generators allowed to determine activities that constitute WM.	EPA stated in preamble to regulations that would attempt enforcement only of manifest certification.	No apparent enforcement underway. Minimum enforcement would require visits to generators and TSDFs to ascertain if manifest WM statement signed or operating record contains annual WM program information. Since generators determine activities, compliance would not indicate if waste reduction has occurred.	Enforcement activities unknown.

SOURCE: Office of Technology Assessment, 1986.

that waste reduction is not deemed as newsworthy as the more visual aspects of pollution control, particularly its failures. For example, companies that have won honors for successful waste reduction have received little, if any, news coverage—unlike those that have polluted the environment. The company that is not generating waste provides scant fodder for reporters and few photographic opportunities for cameramen.

What does all this mean in terms of congressional action? With regard to industry, common sense suggests that massive reduction of waste is not possible overnight. But available information supports the view that eventually large-scale waste reduction will be possible technically and economically. Supportive private sector efforts, which are just now being initiated, are likely to promote more waste reduction by industry. **Commitment to the national policy goal and well-informed planning for its implementation can be assisted by Federal leadership.** But how much waste reduction is possible? Exactly how much has been going on? What are its economic and environmental benefits? These important questions cannot now be answered with detailed, reliable data. Nor is it possible to quantitatively calculate the positive and negative impacts of certain government actions on specific wastes or industrial waste generators. These limitations do not necessarily rule out Federal leadership, but they do favor some types of government action over others.

The Primacy Issue

For the Environmental Protection Agency (EPA), industry, and environmentalists, waste reduction has consistently appeared as the ideal waste management option—the *concept* is universally embraced even though the option is not vigorously implemented. Even though EPA acknowledged that waste reduction should be given top priority in 1976,[9] this theoretical priority has not been matched either by action or by resources. Now that the implementation of waste reduction is receiving more attention, the fact that its definition has not been made clear poses a serious problem.

Ironically, the goal of reducing the use of land disposal detracts from the goal of reducing waste. If waste reduction is defined to include waste treatment, then attention is diverted away from true waste reduction. The goal of waste reduction subsumes the goal of reducing land disposal, but the goal of reducing land disposal does not mean that the alternative chosen will be waste reduction.

EPA and State agencies spend at most about $4 million annually on activities related to waste reduction. This is less than 0.1 percent of total government spending on pollution control programs. The Department of Defense, however, has committed larger sums of money for waste minimization, but they define it to include waste treatment (see ch. 5).

Industry probably spends significant sums on waste reduction—possibly a much greater percentage of its environmental spending than the government allots, although these figures cannot be determined. **Waste reduction tends to lose out to waste management in the press of immediate concerns,** such as siting waste management facilities, developing alternatives to land disposal, and determining safe levels of emissions. Little recognition is given to the fact that effective waste reduction methods can lessen these needs. **Pollution control is often perceived as being the safer choice because the technologies of waste management are more familiar than those of waste reduction and there is no risk of impairing product quality. In actuality, there is no such risk with many ways of reducing waste.**

Some waste generators say that they have reduced their wastes as far as is feasible; others believe that waste reduction makes sense only in the longer term. **Waste reduction is often seen as a long-term ideal rather than as an immediate and practical route for industry and government to pursue.** This appears to be primarily a consequence of resource commitment to and familiarity with pollution control rather than to technical constraints.

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[9] 41 CFR 35050, Aug. 18, 1976.

Many industry actions have some potential for promoting or hindering waste reduction, but these are rarely examined explicitly. **Waste reduction is seldom seen as a criterion to measure job performance or performance in meeting government environmental protection requirements, developing production technologies, and setting research agendas.** Offering rewards and incentives for workers and managers who find ways to reduce waste can be an especially important strategy.

Goals for waste reduction could be established just as, for example, people target a certain annual increase in the gross national product or in productivity. Goals could help maintain interest in reducing waste. Some companies report involvement in goal-setting,[10] but for the most part, **there has been little use of the technique of setting target figures for waste reduction at the plant, company, industry, or national level.**

The Case for the Primacy of Waste Reduction

Why should waste reduction be given primacy over waste management by industry? Excluding the factors of transport and storage, waste management can be divided into three categories: 1) recycling or reuse away from the source of waste generation; 2) treatment or conversion, which physically destroys or chemically detoxifies or otherwise renders waste permanently harmless; and 3) disposal, which puts waste into the air, water, or land. Environmental regulation has not necessarily required the first two preferable options and has often led inadvertently to very ineffective disposal which has caused problems so severe as to have necessitated repeated redisposal. However, if a treatment permanently renders all or most waste harmless, then it is *effective waste treatment*—i.e., its benefits approach those of waste reduction. Both offsite recycling and effective waste treatment are preferred waste management options, but both pose more risks than waste reduction because waste is handled, stored, and transported. The possibility of mismanagement or failure of technology cannot be disregarded. Accidents can occur at both recycling and waste treatment facilities. About 10 percent of the Superfund sites on the current National Priorities List are these types of facilities.

The limited data available indicate that most RCRA hazardous waste is still land disposed—by one estimate for 1983, 68 percent was deposited in or on the land[11]—and available data for the past several years do not yet show a major shift away from land disposal. Less than 2 percent of RCRA regulated waste is incinerated, and not much more is permanently treated in other ways or recycled. Sometimes data for a company or an industry show a drop in land disposed waste, but this may be due to declining production.

Often what is called treatment of waste is simply removal and transfer. For example, evaporation ponds and air stripping columns used for treating liquid wastes purposefully put volatile toxic chemicals into the air, and adsorption materials used to remove toxic chemicals from liquids or gases are generally land disposed. Statistics for industrial hazardous pollutants in waste streams sent to publicly owned water *treatment* plants indicate that only about 50 percent are permanently altered; the rest remain hazardous and are released into the air as volatile emissions, discharged into surface waters, or put into the land as sludge, where hazardous substances can migrate into groundwater.[12] There are concerns about emissions of unregulated toxic chemicals resulting from incineration; according to EPA more than half of hazardous waste incinerators in 1981 used no air pollution control systems at all.[13]

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[10] Some companies have said that they do not use numerical goals, while others indicate that they may use them. For example, 3M has said that it reduced potential hazardous waste generation by 50 percent in the past 10 years and that it hoped to repeat that in the next 5 years. Chevron Chemical Co. has said that specific waste reduction goals are set by each of its plants. [*Waste Reduction: The Untold Story*, proceedings of a League of Women Voters conference, Woods Hole, MA, June 1985.] Du Pont has also announced that it is preparing a goal for 1990. The Department of Defense is preparing waste reduction goals.

[11] U.S. Congress, Congressional Budget Office, *Hazardous Waste Management: Recent Changes and Policy Alternatives* (Washington, DC: U.S. Government Printing Office, May 1985).

[12] U.S. Environmental Protection Agency, *Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works*, EPA/530-SW-86-004 (Washington, DC: Office of Water Regulations and Standards, February 1986), p. 7-6.

The widespread potential for cross-media transfer in waste management and treatment is an important reason for giving primacy to waste reduction. Two examples illustrate how existing environmental programs can lead to cross-media transfers of pollutants:

1. Air pollution and water pollution control or treatment techniques produce hazardous solid waste such as baghouse dusts and sludges that include toxic metals, often in very large quantities. At one major commercial hazardous waste landfill these types of wastes accounted for 25 percent of its receipts in 1984. At a major petroleum refinery, fully 60 percent of all the hazardous wastes come from required air and water pollution control devices.
2. Solid waste surface impoundments, landfills, water treatment units, and some cleanups of contaminated groundwater and soil release unregulated toxic air emissions. An EPA study found the Northeast Philadelphia Sewage Treatment Plant to be the largest single source of air toxics in the entire metropolitan area, greater than such major industrial facilities as refineries and chemical plants.

Another reason for giving primacy to waste reduction is that the current regulatory system sanctions the generation of certain amounts of waste, and these can accumulate to environmentally unacceptable levels when postpollution control discharges from many generators enter the environment. Regulatory permits given to a generator for specific wastes are not necessarily based on standards, but rather on what is technically feasible for the generator. Nor is there necessarily effective enforcement of the limits imposed by permits. Moreover, certain kinds of wastes, such as toxic chemicals, are not necessarily covered by permits geared to conventional pollutants. The result is that large amounts of legal and illegal waste discharges are entering the environment. For example, an EPA study found that over 3,000 tons of toxic metals were entering the Chesapeake Bay annually from industries in Maryland and Virginia. Many believe that cumulative discharges of hazardous waste have played a role in the declining marine life of the Bay. (For example, even while environmental regulations escalated, commercial catches of striped bass fell from 6 million pounds in 1970 to 600,000 pounds in 1983. Oyster harvests have dropped by two-thirds in the last 20 years.)[14]

In sum, to an unacceptable degree, hazardous waste management involves disposal or dispersal of waste into the environment. Some of this pollution may not be too troublesome. For example, the atmosphere or the ocean may be able to assimilate fairly large quantities of some substances without causing harm to the environment or to human health. But much of this disposal or dispersal into air and water is known to pose severe environmental threats. Many land disposal practices, which have been proven harmful, illustrate this point. In many other cases, the long-range effects of disposal and dispersal practices can only be classified as unknown. Effective waste treatment is often expensive, which is why most wastes are not treated effectively. Even when new technology makes lower costs possible, firms offering these technologies often encounter market entry problems that limit the availability of these methods. For example, there is a host of technical, economic, and institutional explanations for the fact that recycling is not used more widely. Waste disposal, which generally has the lowest direct cost, should be permitted only when the user is able to demonstrate that waste disposal will accomplish environmental protection and that no costs will be shifted to other parties. But at present waste generators often only have to deal with the *immediate* costs of land disposal, and government still sanctions its use for many wastes rather than limiting it to the residues of treatment, which will always require land disposal.

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[13] E. Timothy Oppelt, "Hazardous Waste Destruction," *Environmental Science and Technology*, vol. 20, No. 4, April 1986, pp. 312-318.

[14] "The Poisoning of Chesapeake Bay," *The Washington Post*, June 1, 1986, p. 1.

The most important reason why waste reduction should be the first option of generators is because all waste treatment and recycling facilities pose some environmental risk and thus require effective regulation. The most certain means of preventing environmental risk is through waste reduction. Waste reduction is also preferable to most waste management practices because it can lead to lower direct costs and higher indirect benefits. As a recent report by the French Government said: "Avoiding the creation of pollution seems to be the best way to fight against it, technically and economically."[15] Similarly, analysts in the U.S. waste management industry studying alternatives to land disposal of hazardous waste recently concluded:

> Obviously, the most preferred is the prevention of generation. This option usually is the least costly and does not require other management options, such as detoxification or volume reduction.[16]

If waste reduction has primacy, then: 1) its possibilities should always be thoroughly explored before waste management is used, and 2) the allocation of public and private resources should reflect its priority. As will be discussed later with regard to technology, the fact is that significant waste reduction *is* underway and experience in the United States and elsewhere indicates that **waste reduction is a near-term practical option,** even though it is not possible to estimate accurately the upper limit of how much is technically and economically feasible.

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[15] Michael R. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986), p. 29. Based on Ministere de l'Environnement, *Les Techniques Propres dans l'Industrie Francaise*, translated by Michelle L. DeHertogh.

[16] R.J. Schoenberger and M.H. Corbin, "Technologies for Hazardous Waste Reduction—A State of the Art Review," paper presented at Third Hazardous Waste Management Conference, Philadephia, PA, June 1985.

THE INTERNATIONAL DIMENSION

Have other nations also come to the conclusion that waste reduction is important? The degree of interest in waste reduction among governments in other industrialized nations varies (see app. B). Some governments have taken little or no action. The United Kingdom, for example, has decided to concentrate its efforts on ensuring adequate waste management, while Japan has concentrated on promoting reuse or recycling technologies. Other governments are just beginning to take action. Canada has, until recently, left waste reduction up to its Provinces. Ontario, for example, has initiated substantial waste reduction efforts. This situation is likely to change, however; the Canadian Federal Government will be holding a major policy planning meeting in October 1986 to outline a plan for coordinated Federal and Provincial action on waste reduction.

Most European governments (e.g., France, the Federal Republic of Germany, Sweden, Norway, Denmark, The Netherlands, and Austria) have exercised more leadership in waste reduction and have devoted more money to waste reduction than the United States. While the development of governmental programs to promote waste reduction dates from the early 1980s in the United States, these West European countries have been supporting the concept of "low- and non-waste technologies" (or "clean technologies") since the 1970s. As is the case here, there are no data from European countries on which to base an assessment of waste reduction, so it is impossible to know if government activity has resulted in higher levels of reduction there than here. Differences in definitions for hazardous waste and waste reduction also hamper comparisons both between Europe and the United States and among European nations. However, it is important to note that European nations have generally not established as extensive environmental regulatory programs as has the United States. This absence of a pollution control culture may have helped to facilitate interest and investment by Europeans in waste reduction.

The experiences of these governments in promoting waste reduction among their industries may be instructive to U.S. policymakers. European governments have focused on assistance to and cooperation with waste generators as well as on government and industrial planning for waste reduction. This is consistent with their nonregulatory approach to environmental protection.

West European experiences may also present a challenge to the United States because waste reduction has been used as a tool to improve industrial efficiency, growth, and international competitiveness and not solely for environmental protection. Some U.S. firms have also taken this position. For example, a Du Pont executive has said:

> Waste reduction can also give us a leg up competitively. In the past, few companies factored the costs of waste disposal into their manufacturing processes. Today, an economical and environmentally acceptable plan for waste management may well make Du Pont the low-cost producer—and hold the key to the success or failure of many of our businesses.[17]

To the extent that Europe's lead in waste reduction results in more efficient processes and increased productivity among European industries, U.S. firms in similar industrial sectors may be placed in an inferior competitive position. In addition, to the extent that a profitable worldwide market for waste reducing technologies and techniques opens up in the coming decade, U.S. firms may find it difficult to sell their waste reduction expertise to industrial operations here and overseas if Europeans are offering a wider variety of better techniques that have been tested over a longer period of time.

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[17] Paul A. Chubb, *Wasteline*, Spring 1986. This publication is Du Pont's new waste reduction newsletter.

ISSUES AND FINDINGS

To summarize the material in subsequent chapters, OTA has defined eight issues which are presented here together with OTA's findings and brief explanatory discussions.

SUMMARY ISSUE 1:
Is waste reduction measured correctly in common practice?

OTA Finding:

Some companies do measure waste reduction correctly. They determine how the generation of a specific waste from a process has changed over time by reference to a unit production output. It is even more useful to determine how specific hazardous substances within the waste have changed, again on a unit production basis. For a new process or product, the levels of waste generation that occur with waste reduction measures should be compared to what would have been generated without waste reduction. No current public database on waste generation is coupled with information on production output and no significant amounts of disaggregated (i.e., plant- and process-specific) waste reduction data are in the public domain. Waste generation information is thus likely to be misleading about waste reduction.

Discussion

A major problem in analyzing waste reduction is deciding exactly how it should be measured and described. **Waste reduction is far more difficult to document with meaningful data than it is to talk about in general terms**. Most of the limited data on waste generation available to policy analysts are too aggregated over processes, plants, companies, and sometimes industries to prove or disprove that any given degree of waste reduction is taking place. Moreover, the national database on the *generation* of hazardous waste is in very poor condition. Ten years after RCRA was enacted, the data on waste generation are generally accepted to be incomplete, out of date, unreliable, and sadly lacking in detail. EPA itself has recently said that: "vital data and analytical techniques are still lacking."[18] Only a few States have information that is more useful than that in the national database.

For hazardous wastes not regulated by RCRA, the situation is no better. The most obvious problem is that of toxic air emissions; there is no reliable database for the range of toxic chemicals being released in large quantities into the atmosphere.[19] As to water, there has been no systematic nationwide collection of data on the actual (rather than permitted) levels of discharges for the full range of wastes, nor has there been a tally of permitted levels.

In other words, the current pollution control regulatory program has not given the Federal Government the sort of extensive data that will chart exactly what wastes are coming out of every industrial operation. It is not at all clear that even plant operators usually have this information.

Because almost everyone in the regulatory agencies and industry has been preoccupied with pollution control, the focus has been on amounts of waste generated. When interest shifts to waste reduction, however, statistics on the absolute amounts of waste generated do not suffice. **The problem in examining any waste generation data (national, State, or company level) is that over time industrial activity changes, product mix changes, and environmental regulatory requirements (which determine what is counted as a waste) change; all three factors strongly affect waste generation figures. Increasing economic activity and production might mask waste reduction. Alternatively, aggregated waste generation data which show a decline over time may result from a recession or from treatments that change waste volume, such as dewatering and waste stream separation, without any reduction in toxicity or level of hazard.** If one major industrial plant maintains a very high volume aqueous waste stream this can greatly affect aggregated data for an industry segment on a State or even national basis.[20] Although they may greatly reduce waste management costs to the generator, *actions that reduce waste volume by concentrating the hazardous content of a waste or that reduce hazard level by diluting the hazardous content are not considered waste reduction in this report.*

A good measure of waste reduction might be on a process basis, such as the amount of waste per hour of electroplating; an even better measure may be based on production, such as the amount of waste produced per pound of chemical or per computer. Indeed, several companies have said that putting waste generation on a production output basis is how they measure waste reduction.[21]

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[18] Gary M. Katz, Director, Management and Organization Division, U.S. Environmental Protection Agency, memorandum on "Reorganization of the Office of Solid Waste," to Howard M. Messner, Assistant Administrator, May 7, 1986, attachment 1.

[19] For example, in an unusually candid EPA document, the quality of the Nation's air toxics emissions data was discussed. Comments included: " . . . the emissions data base for air toxics is quite poor . . . " "There are presently no continuing and comprehensive Federal emission inventory data bases maintained on air toxics. There are no regularly updated, computerized, emission inventory systems . . . " "The existing air toxics emissions summaries come from a hodgepodge of EPA reports, articles, etc." [Tom Lahre, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, "Characterization of Available Nationwide Air Toxics Emissions Data," June 13, 1984.]

[20] For example, data over a 4-year period for 324 chemical plants indicate that solid hazardous waste decreased from 3.3 million tons in 1981 to 1.3 million tons in 1984, and hazardous wastewater decreased from 207.8 million tons in 1981 to 175.2 million tons in 1984. Some of this decline in waste generation is undoubtedly a result of waste reduction. However, concentration of hazardous substances, changes in production levels, and other factors may also contribute to the changes. [Chemical Manufacturers Association, "Results of the 1984 CMA Hazardous Waste Survey," January 1986.]

[21] *Waste Reduction—The Untold Story*, proceedings of a League of Women Voters conference, Woods Hole, MA, June 1985. But no detailed waste reduction data on a production output basis are given, although Monsanto Co. noted: "Absolute total waste generation volume decreased only 1.7 percent from 1982 (our 'base year') through 1984. Unit generation, however (pounds of waste/pounds of production), decreased *19.7 percent!*" This illustrates how important it is to put waste reduction on a production output basis. There were other examples, in answer to a question on how waste reduction is defined. Exxon Chemical Americas said: "Also use an index of tons of waste divided by tons of product produced for comparison on a year to year ba-

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Consider data from the Sanford, North Carolina, plating operation of Stanadyne, Inc. From 1983 to 1985 waste sludge decreased from 115,000 pounds to 110,000 pounds, just over 4 percent. But production hours had increased from 2,380 to 4,550. Waste generation in terms of production output dropped from 48.3 pounds per hour to 24.2 pounds per hour, almost a 50-percent decrease. This is the correct measure of waste reduction. Even if waste generation had increased 30 percent to 150,000 pounds in 1985, there still would have been 32-percent real waste reduction. In other words, the correct measure of waste reduction provides a remarkably good indication of the level of efficient use of materials in industrial operations.

One problem with this method is that **putting waste reduction on a production output basis raises concerns in companies about revealing information they consider confidential. However, it is not necessary to report actual production data. All that is necessary is to give the final waste reduction percentage based on waste generation *and* production data, *not* based solely on changes in the absolute amounts of waste generated.**

Disaggregated waste percentage data can then be pooled to obtain weighted (in terms of relative amounts of waste) waste reduction averages over a number of processes or operations, or even plants of a company, or companies of an industry (see box 1-D). This kind of averaging, or pooling, gives a true measure of waste reduction and avoids proprietary problems. The key is to come up with disaggregated percent waste reduction figures that are clearly understood to be derived from production-based waste generation data; without the production base there can be no valid measure of waste reduction.

There is one more critical problem in the measurement of waste reduction, even when using the approach just discussed. In the above example, there was an implicit assumption that the chemical nature of the waste did not change. If a waste is not totally eliminated, however, actions taken to reduce waste may also change the chemical composition and the concentrations of the components of the waste. Therefore, *examining changes in just the amount of waste generated relative to production may not reveal whether there has been a change in the degree of hazard of the waste.* Without a decrease in the degree of hazard of the waste, the action is not considered waste reduction. For example, as mentioned previously, large aqueous waste streams are generated by the chemical industry; some actions can reduce the water content but not the amount of hazardous substances in the waste. Dewatering of a sludge is another example of reducing the volume and concentrating the hazardous content of a waste. Neither case should be considered waste reduction.

Some waste reduction actions, such as changing process technology, may reduce some hazardous components but increase others or introduce new ones. Unless the basic chemistry of a waste has remained constant, waste reduction data may not accurately indicate what has occurred.[22] Several questions need to be answered in order to flag suspect or meaningless waste reduction data: Has the waste reduction resulted from an action that concentrated hazardous content? Has the waste reduction resulted from an action that changed the chemistry of the waste? Has the waste reduction resulted from some unknown activity? Unless a negative answer can be given to these questions with certainty, the bare waste reduction data (on a production output basis) may not accurately reflect what OTA defines as true waste reduction. To go much beyond asking these simple questions would, however, require considerable analytical effort.

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sis. This index properly considers growth via new products or additional production. This index is similar to commonly used energy indexes." Du Pont said: "Amount reduced per ton of product—i.e., waste could increase in pounds, but still be reduced as a fraction of production." Olin Corp. said: "Reduction in quantity of waste generated per unit of product produced." Amoco Chemicals Corp. said: ". . . waste reduction is . . . a decrease in the amount of waste requiring disposal per unit of product produced."

[22] This is also the case if a "dry weight" of an aqueous waste is used. While changes in dry weight avoid the problem of reporting changes in water content only, they do not necessarily reveal changes in the hazardous content of the nonaqueous portion of the waste.

Box 1-D.—The Measurement of Waste Reduction

Case #1: Waste reduction for a specific waste generating industrial process or operation for which a production output can be identified and there is no change in the chemical makeup of the waste.

$$\text{Percent Waste Reduction} = WR = [(A - B)/A] \times 100$$

where,
A = amount of waste generated in the previous year/production output
B = amount of new waste generated in the previous year/production output)

Example calculation, given that:

in year	*chemical produced*	*waste generated*
1984	500,000 pounds	50,000 pounds
1985	600,000 pounds	40,000 pounds

then,
$A = 50{,}000/500{,}000 = 0.1$
$B = 40{,}000/600{,}000 = 0.07$

and

$$WR = [(0.1 - 0.07)/0.1] \times 100 = 30 \text{ percent waste reduction}$$

Thus, waste was reduced by 30 percent on a production output basis from 1984 to 1985 while chemical production increased 100,000 pounds (20 percent). If waste generated in 1985 had been 55,000 pounds (i.e., an absolute increase of 10 percent in amount of waste generated), then on a production output basis there would still have been waste reduction since:

$A = 0.1$
$B = 55{,}000/600{,}000 = 0.09$

and

$$WR = [(0.1 - 0.09)/0.1] \times 100 = 10 \text{ percent waste reduction}$$

Case #2: Waste reduction for a plant with more than one waste generating process or operation.

$$\text{Overall Percent Waste Reduction} = WRtotal = (M1/Mtot)WR1 + (M2/Mtot)WR2 + (M3/Mtot)WR3 + \ldots (Mn/Mtot)WRn$$

where,
Mn = amount of waste from nth (first, second, third, . . . nth) waste generating process or operation
$Mtot$ = total amount of waste generated in plant operations
WRn = percent waste reduction from the nth waste generating process or operation

Case #3: Waste reduction for a company with more than one waste generating plant or an industry with more than one waste generating company would be calculated as above, with the weighted percent waste reduction figures for the plants or companies and Mtot for the company or industry.

The best way to measure waste reduction is to determine the changes in the absolute amounts of hazardous components. This is considerably more expensive than obtaining data on changes in the total amounts of waste. Without guidance on the relative degrees of hazard of specific hazardous substances, waste generators could face burdensome analytical costs for periodic measurements of the complete chemistry of their wastes, which may be highly complex and vary over time. The current regulatory system has, for the most part, done little to differentiate hazard levels among the many hundreds of common hazardous substances. Therefore, if the government is to encourage effective waste reduction, it may have to assist generators in selecting the most hazardous components of wastes for measurement and reduction. The National Research Council stated:

> To encourage waste reduction practices, the committee recommends modification to the regulatory definitions to include the degree of hazard.[23]

If the government does not establish a means to differentiate among hazardous substances, then using changes in the amount of waste on a production output basis in combination with flagging data that should be excluded is the best compromise. This method would also be a substantial improvement over the current practice of making measurements of waste generation that are uncorrected for changes in production output.

SUMMARY ISSUE 2:

Is the absence of solid information on waste reduction a barrier to government and industry's ability to take initiatives to step up waste reduction?

OTA Finding:

Rather than delaying waste reduction while more data are collected, the development of better information can be made part of waste reduction programs. An information gap does not have to be a barrier to waste reduction initiatives by government and industry, but initiatives should emphasize the need for acquiring better information to document their effectiveness and progress. Even if the government were to take no further action, there would still be a critical need to obtain information on the national waste reduction effort.

Discussion

Opinions about the current state of waste reduction—how much is possible, and whether further government action is needed—are based almost entirely on perceptions, anecdotes, and examples rather than on systematic data. Only a monumental government effort could compile systematic and reliable data on waste reduction for American industry. *The experience with the RCRA waste generation data system shows that it would be remarkably difficult for government to gather and analyze accurate and timely data from a very large number of companies and for an even larger number of processes and waste streams.* Even reliable data would not reveal what actions, out of a broad range of possibilities, a *specific* industrial operation might reasonably undertake to reduce waste, because so much of what is technically and economically feasible is site-specific.

The costs and benefits of overcoming these obstacles are difficult to assess but are probably substantial. Nevertheless, this uncertainty and the *time* it would take to put together extensive data on waste reduction do little to resolve current questions, which must be addressed in formulating policy recommendations. Should government pursue some direct approach for spurring waste reduction in the near term? Or should it wait and give the system a chance to respond to current indirect incentives (which are working to some extent)?

SUMMARY ISSUE 3:

Can industry implement waste reduction while remaining in compliance with pollution control regulations?

OTA Finding:

Environmental protection argues for simultaneous efforts toward reduction and control. But practical limits to industrial resources suggest that many waste generators may need regulatory flexibility and technical assistance to permit a smooth transition from pollution control to waste reduction.

Discussion

The current state of waste reduction in industry raises a number of issues for industry itself, for government, and for other individuals or organizations interested in examining waste reduction. In industry, as in government, waste reduction has generally been a part of existing pollution control efforts. **Companies with major waste reduction programs, however, often shift waste reduction to the production arena.** The historical linkage of waste reduction to pollution control may be one of the obstacles faced by government and industry in their attempts to promote widespread waste reduction.

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[23] National Research Council, *Reducing Hazardous Waste Generation* (Washington, DC: National Academy Press, 1985), p. 31.

For example, Federal regulatory programs in themselves are sometimes counterproductive or inattentive to waste reduction; they are mostly driven by available, proven pollution control technology rather than by health and environmental considerations. This means that certain levels of waste generation are approved by regulations. The result, therefore, is that end-of-pipe regulatory programs legally allow the generation of hazardous waste and do not *directly* stimulate waste reduction. **Of course, the pollution control approach does offer environmental protection. Waste reduction, however, offers more, and the government's approach to environmental protection has kept attention and resources from being directed towards waste reduction.**

Telling industry to comply with pollution control regulations and simultaneously reduce waste ignores practical limits to industrial resources. Regulatory compliance is expensive. For many companies, capital investments for pollution control and the costs of regulatory compliance can foreclose any but the simplest efforts at waste reduction, even though successful waste reduction will very quickly reduce regulatory compliance and waste management costs. **The difficulty for a generator, then, is to continue to invest and spend on regulatory compliance and improved waste management while at the same time investing and spending on waste reduction.** It seems like a Catch-22 situation. The answer may be not to force a choice between waste reduction and pollution control. If flexibility can be introduced into the current regulatory system and if assistance for waste reduction is offered, switching emphasis over to waste reduction can be facilitated. But while the transition is being made, environmental protection must be maintained. As will be discussed in chapter 3, waste generators will unavoidably face an investment-uncertainty hurdle as they proceed with waste reduction.

SUMMARY ISSUE 4: Has U.S. industry reduced the generation of hazardous waste to the greatest degree possible?

OTA Finding:

Waste reduction is a dynamic opportunity contingent on a host of changing technical, economic, human, and institutional factors. Thus, substantially more waste reduction is feasible and more will become feasible. Setting a national voluntary waste reduction goal of perhaps 10 percent annually for 5 years could be useful.

Discussion

Some companies believe that there are few if any remaining waste reduction opportunities. In particular, some larger companies feel that they have accomplished all the waste reduction that they can. Many of industry's statements about waste reduction are reminiscent of 1970's statements about industrial energy conservation. What this means is that, to a significant extent, **waste reduction may be blocked by individual attitudes based on limited information and experience, rather than on lack of effective technology.**

- Are managers, design engineers, researchers, and plant engineers and workers familiar with all the technical means to reduce waste?
- Have they examined all waste reduction opportunities? Does their organization reward waste reduction efforts?
- Have they been able to see the economic value of a waste in terms of its worth as wasted raw material and its costs as a pollutant to be managed and as a potential liability?
- Do environmental engineers who are trained in and preoccupied with end-of-pipe man-

agement consider front-end changes? Are they technically equipped to recognize waste reduction opportunities throughout a process?

- Are traditional mass or material balance calculations, which some companies perform to describe inputs and outputs, sensitive enough to reveal small amounts of waste that may be of great economic and environmental significance?
- Do companies consider reducing all wastes, including those that are unregulated or are currently released into the environment according to the limits imposed by a permit?

While no generalization is correct for all companies, OTA finds that for the most part the answer to all the above questions is "no." The conclusion is that there are substantial opportunities for waste reduction, even though it is not possible to give numbers for specific wastes and industries. **The challenge is to persuade and assist most American waste generators to do what a few companies have already discovered is in their own economic self-interest**.

Rather than attempting to forecast future amounts of waste reduction, which cannot be done with accuracy because of the nearly unbounded methods of implementation and because of site-specific limitations, **it might be more useful to focus on a voluntary waste reduction goal. Government could set, for example, a goal of perhaps 10 percent annually over 5 years for plants, companies, and the Nation as a whole. This level of activity appears feasible, based on reports of recent successful efforts.** For example, a survey asked various large companies whether, after accounting for production changes, waste generation had decreased from 1984 to 1985. The answers are impressive. The percentage reductions reported are: Rohm & Haas, 10 percent; Exxon Chemical Americas, 10 percent; Olin, 34 percent from 1981 to 1985; Du Pont, 50 percent and 35 percent for two divisions; 3M, 50 percent over 1975 to 1985; and two companies, which did not put data on a production output basis, indicated that generation dropped: IBM reported a drop of 17 percent; Hewlett Packard, 16 percent for the years 1983 to 1984.[24] Naturally, not every waste generator would be able to match figures such as these. **If a national goal were to be set, it should not be as a regulatory requirement, but as a way to stimulate interested and informed support for implementing waste reduction.**

It is difficult to know, however, how far publicized waste reduction success stories can be extrapolated. Companies that are not pursuing waste reduction goals normally remain silent. Some companies do not agree with this optimistic view of waste reduction possibilities because they feel that limitations are posed by their site or their history. However, most people working in the field are optimistic about the potential for waste reduction. A recent major study of waste reduction in 29 organic chemical plants is significant.[25] Some of its findings were:

> . . . despite the kinds of benefits companies could reap from waste reduction, and despite all the talk about the critical importance of this strategy by those in and outside the industry, waste reduction initiatives were actually affecting only a tiny fraction of the total wastes generated by our 29 plants. It is our belief that virtually every facility generating wastes in the form of air emissions, wastewaters and solids has substantial and beneficial opportunities to pursue waste reduction at the source.[26]

Another study of waste reduction made the same point:

> . . . most of the industrial efforts in the nation are currently in the initial phase in the development and implementation of hazardous waste reduction programs. Significant opportunities exist to reduce the generation of hazardous waste . . . [27]

A Du Pont official recently said:

> We will see considerable reductions in the percentage of waste generated per pound of

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[24] *Waste Reduction—The Ongoing Saga*, proceedings of a Tufts University Center for Environmental Management conference, Woods Hole, MA, June 1986.

[25] David Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985).

[26] David Sarokin, "Waste Reduction in the Organic-Chemical Industry," paper presented at Government Institutes' Hazardous and Solid Waste Minimization Conference, May 1986.

[27] National Research Council, *Reducing Hazardous Waste Generation* (Washington, DC: National Academy Press, 1985), p. 5.

product produced, just as we have seen reductions in the consumption of energy over the last ten years.[28]

Finally, a senior EPA official recently said: "Principally, I agree that not enough waste reduction is going on at present."[29] The Department of Defense is establishing goals for large amounts of waste reduction.

SUMMARY ISSUE 5:
Do technological limitations pose a major obstacle to waste reduction?

OTA Finding:

The phrase *waste reduction technology* is misleading. It is more useful to think of waste reduction in terms of a wide range of latent technological opportunities that exist throughout the production system. These opportunities can be taken advantage of with a spectrum of technical means that vary greatly in technical complexity, cost, and effectiveness. The technical and economic feasibility of waste reduction has meaning only in the context of and from the perspective of a specific industrial plant operation. While some means of waste reduction are transferable from one site to another, it cannot be assumed that what works at one place will be both technically and economically feasible at another. However, there are some waste reduction opportunities that are broadly applicable because they employ commonly used materials and are effective for commonly used processes.

Discussion

OTA has concluded that waste reduction should be viewed as a criterion to assess almost any industrial process and operation rather than as a unique type of technology, machine, or even field of expertise (see ch. 3). **The technological means to reduce waste are imbedded in all aspects of the production system.** Therefore, the phrase *waste reduction technology*, although it is convenient to use, can lead to confusion. Five classes of waste reduction are identified in this study:

1. recycling of a [potential] waste or part of it at the site of its generation;
2. improvements in process technology and equipment that alter the primary source of waste generation;
3. improvements in plant operations (e.g., better housekeeping, improved materials handling and equipment maintenance, better monitoring and automation of process equipment, and improved waste tracking or mass balances);
4. substituting raw materials that introduce fewer hazardous substances or smaller quantities of such substances into the production process; and
5. redesign or reformulation of end products.

These options are given in order of decreasing use as reported by the 99 companies included in OTA's industry survey. Table 1-2 summarizes an analysis of major published case examples of waste reduction in terms of the distribution of these five approaches over industrial categories (also included is a class that includes measures deemed waste management by OTA). The pattern of usage is the same as that derived from the survey. In-process recycling is the method closest to pollution control, which may make it the easiest option to recognize and implement. But there are important limits to recycling, mostly of an economic nature. Moreover, many times there are other waste reduction measures possible that offer greater benefits.

Contrary to what is sometimes said because of concerns about product quality, improvements in process technology and equipment appear to be a practical means to waste reduction. Such improvements are very important because often an entire waste stream can be eliminated. The literature of case studies and examples of successful waste reduction reveal that, contrary to what is often assumed, this approach is often possible without significant capital investment.

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[28] J. Howard Todd, "Waste Reduction . . . Industry's Challenge," paper given at Lindbergh Symposium on Environment and Technology, Orlando, FL, February 1986.

[29] Christopher J. Daggett, speech given at New Jersey Institute of Technology symposium, *Waste Reduction: How To Make It Happen*, Mar. 12, 1986.

Table 1-2.—Industry Use of Waste Reduction Methods

		Waste reduction methods						
SICs	Industry	In-process recycling	Plant operations	Process technology and equipment	Process inputs	End products	Waste management	Totals
10	Metal mining	—	—	—	—	—	1	1
14	Nonmetallic mining except fuel	1	—	—	—	—	—	1
16	Heavy construction	—	—	—	1	—	—	1
20	Food and food processing	6	—	2	—	—	5	13
22	Textile mill produces	6	—	4	1	—	1	12
24	Lumber and wood products	5	—	—	—	—	—	5
26	Paper and allied products	5	1	4	2	—	1	13
27	Printing and publishing	3	—	—	1	—	1	5
28	Chemicals and allied products	30	16	37	6	2	14	105
29	Petroleum and coal products	3	—	1	—		1	5
31	Leather and leather products	3	—	3	1	—		7
32	Stone, clay, and glass products	4	—	8	—	—	—	12
33	Primary metal industries	12	—	11	—	—	7	30
34	Fabricated metal products	23	7	14	5	1	8	58
35	Machinery, except electrical	1	3	4	—	—	4	12
36	Electrical and electronic equipment	4	—	2	1	—	2	9
37	Transportation equipment	1	—	5	1	—	—	7
38	Instruments and related products	1	2	—	—	—	1	4
39	Miscellaneous manufacturing industries	2	—	—	—	—	—	2
49	Electric, gas, and sanitary services	—	1	—	—	—	10	11
76	Miscellaneous repair services	—	—	1	—	—	—	1
	Totals	110	30	96	19	3	56	314

SOURCE: Office of Technology Assessment, compiled from: D. Huisingh, et al., *Proven Profits From Pollution Prevention* (Washington, DC: The Institute for Local Self-Reliance, 1985); *Compendium on Low and Non-waste Technologies* (Geneva, Switzerland: United Nations Economic Commission for Europe, 1981-84), four vols.; M. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986). Originally assembled and developed as *Les Techniques Propres dans l'Industrie Francaise* (Paris: The Ministre Du L'Environnement, 1982); U.S. Department of Defense, Environmental Leadership Project, *Industrial Processes To Reduce Generation of Hazardous Waste at DOD Facilities*, Phase 2 Report: Evaluation of 18 Case Studies, prepared by CH2M Hill (T. Higgins), July 1985; D. Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985); and Federal Minister for Research and Technology (DFVLR), *Environmental Protection Technologies* (Cologne, West Germany: DFVLR, December 1984). (Note that this last volume documents ongoing research rather than industrial application of technologies.)

As waste reduction is increasingly pursued by a generator this may change, but most U.S. efforts have not yet reached that point. The usefulness of this method depends, however, on the type of industry. Mature industries that use continuous processes are likely to have few opportunities for changes in process technology, but they may still have waste reduction opportunities in the other categories. Box 1-E illustrates one possible means of reducing hazardous wastewater from the manufacture of acrylonitrile by changing process technology. In terms of weight, all hazardous wastewaters constitute the single largest kind of hazardous waste.

Improvements in plant operations can be accomplished by every waste generator, typically with little testing or capital investment. Opportunities for raw material changes may not be present everywhere, but substantial waste reduction has been accomplished this way. Clearly, end product changes by a waste generator are the most difficult to accomplish. This is probably the only one of the five classes for which there is not evidence of significant generic waste reduction opportunities.

Generic opportunities are based on commonly used processes or materials and thus are the major means of promoting waste reduction through intensive information transfer and technical assistance. Examples include: replacement of organic solvent raw materials with water-based ones, in-plant recycling of organic solvents, changes in process technology and operations to reduce hazardous wastewater generation, and changing material removal techniques from chemical to mechanical systems.

From the perspective of the plant operator, waste reduction efforts that require significant capital and human resources will always face competition from expenditures related to pol-

Box 1-E.—Possible Process Technology Change for Reduction of Hazardous Wastewater From Manufacture of Acrylonitrile

In 1985 acrylonitrile ranked 38th in the list of the top 50 chemicals made in the United States, ranked 19th out of the 26 organics on the list, and had the highest annual growth rate of the organics during 1975 to 1985 with an average of 6.8 percent. Production in 1985 was 2.35 billion pounds (1.1 million metric tons).[1]

For each metric ton of acrylonitrile product manufactured, 400 metric tons of cooling water are used.[2] For every gallon of cooling tower water circulated, a small fraction called blowdown is discarded to remove the buildup of slime and solids which accumulate during recirculation. This blowdown contains toxic chemicals used as bactericides and fungicides and is a hazardous waste. A typical blowdown ratio is about 0.5 percent of the circulation rate. For the 400 metric tons of cooling water used per ton of product, 2 metric tons of wastewater are generated. About 2.2 million metric tons of cooling wastewater is generated annually.

A closed-loop coolant refrigeration system could be used in place of cooling with water. After the coolant was used to cool the process, it would be compressed to a higher temperature and pressure and then passed through a radiator that would reject the heat to the environment. The operating costs for cooling would be from $17 to $60 per metric ton of product.[3] The costs for managing the traditional cooling wastewater, if the injection well costs are from $0.05 to $0.10 per gallon, are $26 to $52 per metric ton of product.

There is a clear potential for saving perhaps $20 per ton of product if closed-loop, efficient refrigeration is used instead of conventional water cooling. For a 100,000 ton per year plant this means a saving of about $2 million annually. Assuming that the capital costs of the refrigeration system might be $50 million (at most about 10 percent of the original capital costs of the plant), then payback would occur in a few years.

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[1] *Chemical & Engineering News*, Apr. 21, 1986.

[2] *Hydrocarbon Processing*, May 1977, p. 171. The data are based on the Montedison-UOP process which differs from the more widely used SOHIO process primarily because of a different catalyst. However, similar water use and wastewater generation can be assumed for both.

[3] The operating costs of this refrigeration cycle can be estimated making the following assumptions: 1) cooling water temperature rise of 12° F, 2) coefficient of performance ranges from 2 to 7, and 3) energy costs are $0.04 per kilowatt-hour.

lution control requirements and from traditional corporate uses of resources to maintain or improve competitiveness and profitability. Thus, it becomes important to understand that *there is a spectrum of technical means to carry out waste reduction and these vary greatly in technical complexity, cost, and effectiveness.* Not all plant personnel will necessarily have the technical ability or motivation to examine all waste reduction options or to carry them out. Nor should it be assumed that plant personnel are aware of the benefits or need for reducing waste. Senior management must give priority to waste reduction, but this is far from the only requirement.

SUMMARY ISSUE 6:

If waste reduction is so site-specific, would Federal initiatives pose risks and problems for U.S. industry?

OTA Finding:

There are well-founded technical and economic reasons for industry, particularly troubled manufacturing sectors, to have concerns about government initiatives that might be inflexible. Some initiatives might not be sensitive to alternatives to waste reduction and the limited capabilities of some companies or plants within companies to reduce waste.

> On the other hand. Federal actions would have to exert enough pressure on waste generators to bring about serious evaluations of the technical and economic aspects of waste reduction opportunities at their sites.

Discussion

It is difficult to generalize—strictly from a waste reduction standpoint—about what can be done technically within a specific plant operation at a particular time. Equipment, physical layout, control instrumentation, raw materials, product specifications, and volume of output may vary significantly from plant to plant, even for plants making the same product. All of these and probably other factors will affect the applicability and difficulty of any waste reduction approach. Different amounts of R&D, testing, capital investment, and time may be required for different plants. The effectiveness of a given approach to waste reduction will vary among plants, although they use the same process technology or produce the same product. In one operation a given approach may eliminate an entire waste stream; in another operation it might not.

Many large companies that are able to manage their hazardous wastes onsite prefer waste treatment to waste reduction, particularly if they are treating wastes rather than using land disposal. From such an industrial perspective, environmental protection is served by pollution control and waste management methods that are *allowable under the law* and that reduce the use of land disposal. Indeed, many in industry believe that waste treatment is just as valuable a means of achieving pollution prevention as is waste reduction. (On the basis of the thermodynamic principle of steady entropy increase, however, it is more efficient to prevent pollution before waste is created and given a chance to disperse.) Capital and technical requirements for waste reduction may be rejected because so much investment has been made for pollution control. For all these reasons, the flexibility of Federal initiatives is of concern to industry.

It is also difficult to generalize about methods that will be cost-effective, economically feasible, or profitable at a particular site. In general, making quantitative estimates regarding waste reduction is difficult. There are many factors on the cost and benefit sides of the equation that are bound to vary substantially from one generator or waste to another (see box 1-F). Yet being able to predict the *economic* feasibility or practicality of an action at a specific industrial site is critical to those who are about to take action to reduce waste. A great deal depends on the economic circumstances and internal evaluation criteria of a company or a specific plant. Not all companies will apply strict financial criteria, such as a minimum return on investment, in order to carry out waste reduction, but some will. For some, only the more immediate costs and benefits of waste reduction seem important, but other companies factor in uncertain, potentially large long-term liabilities of pollution control. There are also many potential but uncertain benefits that may come from waste reduction. Taking waste reduction seriously may trigger substantial, innovative changes in manufacturing technology. **A new focus on waste reduction offers an opportunity to reappraise and modernize plant process technology**. All too often economic factors are used prematurely to dismiss serious consideration of waste reduction. Thus, while government actions need to be flexible, they also need to exert enough pressure on waste generators to ensure that they take action to evaluate thoroughly the technical and economic aspects of waste reduction measures.

The site-specific character of waste reduction also raises the issue of possible negative effects of government initiatives that might not be sufficiently flexible. For example, the more mature an industrial technology in a plant and the older the plant is, the more costly any but the simplest forms of waste reduction are likely to be. It is often very difficult for existing industrial operations to make capital-intensive changes in basic technology and processes for waste reduction; the situation can be entirely different when new operations are being designed. However, as noted earlier, considerable

Box 1-F.—Problems in Assessing the Costs and Benefits of Waste Reduction

Costs Will Vary

Information.—It is often necessary to spend money on a waste reduction audit, for example, to get detailed information about wastes. These costs can be high for operations that generate many different kinds of waste from a multitude of processes and for firms that change their product mix frequently. For smaller firms with fewer resources these costs may be a significant obstacle. Although an audit may be avoided at the simplest stages of waste reduction, as more complex waste reduction is pursued, it will likely have to be done. It is also necessary to spend money to get information about waste reduction methods.

Testing and R&D.—Sometimes testing and even formal R&D are necessary to: 1) assess the technical and economic feasibility of specific waste reduction measures, and 2) identify risks to product quality posed by some waste reduction measures. These costs are likely to grow as a waste generator moves toward more complex methods to reduce waste.

Capital Investment.—Implementation often involves virtually no capital, but sometimes—and perhaps increasingly so as waste reduction is pursued—significant capital investment may be necessary.

Operations and Production.—Implementation may involve some operating and maintenance costs that should not be ignored.

Training.—Spending on training for workers may be required so that they can implement and work effectively with new waste reducing processes.

Management.—Identification of waste reduction opportunities and effective implementation may require spending on management systems, including better accounting of costs, measurement of waste reduction, and administering reward and incentive programs for workers.

Benefits Are Often Uncertain

Avoided Waste Management.—Savings of all sorts must be assessed, including: 1) direct savings on handling, storage, transport, and treatment or disposal (even if wastes are managed onsite); and 2) indirect savings on the costs of regulatory compliance, legal advice, insurance, and managerial time. Basing estimates of direct savings on current costs may be misleading because waste management costs continue to rise substantially. Estimates of both direct and indirect savings may also be difficult to make because they require anticipating future regulatory actions and their effect on waste management costs and practices. Accounting systems that do not impose waste management costs on specific waste generating activities bias decisions against waste reduction.

Avoided Liabilities.—Assessment of these is necessary, but can be very uncertain. For example, future cleanup costs for contaminated sites and future costs for victim compensation or regulatory noncompliance may be difficult to estimate. A company may have no records on which to base these costs and may not use probabilistic estimates, or may use high discount rates to minimize the effect of long-term costs—both of which bias decisions against waste reduction. If large liabilities exist because of past practices, it may be reasoned that waste reduction to reduce additional liabilities may be insignificant. Unless liability costs are imposed on a specific waste generating activity, decisions may be biased against waste reduction.

Reduction in Raw Material Use.—Often there is a cost saving that is significant over time.

Indirect Economic Benefits.—These may be substantial, but hard to assess. They include: improvements in materials, labor, or energy productivity that reduce operating costs; reductions in costs associated with the presence of hazardous materials such as for worker exposures; more effective use of managers' time; the value of waste reduction in marketing, public relations, and financial transactions. If these benefits are not accounted for, decisions may be biased against waste reduction.

waste reduction is being accomplished without significant capital investment.

Many American manufacturing industries are having major competitive problems marked by plant closings, employment cutbacks, and loss of market share to imports. These industries may face major financial and human resource limitations to waste reduction. **A shift away from a voluntary waste reduction approach is likely to be viewed apprehensively by troubled industries, which already cite the heavy costs of coping with existing pollution control programs. Also, areas with high and persistent unemployment are likely to worry about anything that could further burden their surviving industries. For such companies, assistance and regulatory flexibility may be key.**

SUMMARY ISSUE 7:

Should the Federal Government move from a mostly voluntary approach to waste reduction to a more prescriptive approach?

OTA Finding:

A choice cannot be made between a voluntary and a prescriptive approach on the basis of good, quantitative data because such data do not exist. Moreover, there are other, less extreme, options open to government that might be effective, such as persuasion, assistance, offering incentives, and providing information. Qualitatively, it is possible to conclude that action short of a prescriptive approach could markedly increase the pace and scope of waste reduction. OTA has reached this conclusion based on the following:

- the government has done little to draw attention to waste reduction but has imposed substantial regulatory requirements for pollution control which themselves limit resources for waste reduction,
- there is no generally accepted definition of waste reduction that clearly distinguishes it from waste management,
- there is no standard way to measure waste reduction, and
- there is no consensus or policy that articulates the position that waste reduction should apply to all regulated and unregulated hazardous waste and all environmental media.

Discussion

There is a fundamental antipathy in industry toward government involvement in the front end of production, where waste reduction must take place, and there is a strong belief that the voluntary approach to waste reduction is the proper one. However, any waste management facility—onsite as well as commercial, treatment as well as disposal—poses environmental risks and requires effective government regulation and enforcement. Therefore, some believe that government ought to *require* waste reduction just as it *requires* pollution control measures.

As long as waste reduction is a voluntary effort by industry, the site-specific character of waste reduction can be handled by the individual waste generator. But if government were to *require* waste reduction, it would face major difficulties in determining what is technically and economically feasible or practical for a specific industrial operation. Hence, the wisdom of involving government in production is a critical issue, made all the more difficult to resolve by the substantial uncertainty about how much waste reduction is possible or feasible for industry in general and for specific operations in particular. There is also some uncertainty about how willing industry is to examine and use the full range of options available to implement waste reduction. As a spokesman from the Chrysler Corp. said:

> . . . the economics that have prevailed considered only the 'front door' costs without regard to 'back door' costs. These factors . . . have not caused a sufficient concern to drive new technology with the overall cost viewpoint to product in and waste out.[30]

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[30] *Waste Reduction—The Untold Story*, proceedings of a League of Women Voters conference, Woods Hole, MA, June 1985.

Whether it be for environmental or economic reasons, does waste reduction have primacy in most of U.S. industry? A recent study asked a similar question and concluded:

> The present status (1982-86) is that a major effort in waste minimization [waste reduction as defined here and offsite recycling], across diverse categories of industry has not been undertaken.[31]

Many in industry want to reduce wastes, but do not know how to start or do not know how to move beyond the simplest measures. Others believe that they have accomplished all the waste reduction that they can and that if more opportunities present themselves they will respond in any way that is feasible. But it is not clear what definition they are using for waste reduction; whether they are talking about not generating waste to begin with or whether they are talking simply about avoiding land disposal. It is also not clear whether they are considering the reduction of all hazardous wastes or only those regulated under RCRA. **Often industry sees waste reduction as something that must take its own course, that will be accomplished when its time arrives. This attitude alone is a large barrier to waste reduction.**

Too often, the bare suggestion of Federal action to directly promote more waste reduction, is interpreted as advocating waste reduction by regulation. But OTA finds that the design, implementation, and enforcement of a prescriptive regulatory approach are not technically feasible because of the multitude of diverse, often site-specific waste generating processes. As discussed in chapter 2, there are a number of other options for Federal action that could be effective.

SUMMARY ISSUE 8:

Does the existence of State programs remove the need for Federal initiatives? Do State programs offer clues for Federal initiatives?

OTA Finding:

Current State programs are not substantially increasing waste reduction nationwide. States are primarily concerned with avoiding land disposal and, as a result, State programs promote preferred waste management more than waste reduction. States have found it practical to take a nonregulatory approach to promote waste reduction. Because of low funding and limited staffing, few attempts have been or will be made to measure the effectiveness of State programs. Although States have led the Federal Government in actively promoting waste reduction, a parallel Federal effort is needed to raise waste reduction to a stature comparable to that of pollution control.

Discussion

A small number of States have shown considerable initiative and leadership in moving into waste reduction.[32] Those in State programs are enthusiastic but resources are limited (to no more than 1 percent of overall environmental protection spending). **State programs often deal primarily with waste *management*, not the reduction of waste at its source, even though the term *waste reduction* may be used.** States have not given much attention to non-RCRA wastes and multimedia issues in their programs, and they tend to concentrate on the waste problems of small business.

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[31] Michael R. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986).

[32] This report has not attempted to examine the role of local governments. Many actions which States or the Federal Government might take could also be—and in a few cases have been—applied at the local level. For example, waste reduction plans and goals can be required for local land use permits. See Susan Sherry, et al., *High Tech and Toxics: A Guide for Local Communities* (Washington, DC: Conference on Alternative State and Local Policies, 1985).

OTA finds that 10 States have waste reduction programs in place that: 1) establish an organization responsible for promoting waste reduction, and 2) have moved beyond planning to implemetation of their waste reduction program (see table 1-3 and ch. 6). The North Carolina program (see box 1-G) is the most comprehensive and the most focused on waste reduction. It is unique among State programs because of its multimedia perspective.

Understandably, States pay most attention to local concerns and, therefore, to actions aimed at: 1) discouraging or minimizing land disposal of hazardous waste, a major public issue at the State level; and 2) encouraging the use of waste exchanges and offsite waste recycling as positive alternatives to land disposal, particularly for smaller companies. Waste reduction is not always perceived as a viable alternative for small businesses or as an immediate solution to a pressing issue.

The land disposal of hazardous wastes is an example of a pollution control method that has often failed in the past. States have been spending considerable resources to resolve this emotional, politically charged issue. One recent publication for State officials cautioned:

> Any state legislator must realize, however, that whether or not the sites are developed, the waste *will* be disposed of—legally or otherwise.[33]

No consideration was given in that report to the potential contribution waste reduction might make towards solving this problem.[34] Waste reduction is often viewed as less important and urgent than siting and as representing a diversion of resources. The uncertainty that waste reduction introduces can cloud the market's need for new waste management facilities. **But, waste reduction can be viewed as a *means of alleviating the need* for siting waste management facilities and for *assuring the public that only truly necessary facilities will be sited.*** There are indications that some siting programs are now taking a positive view of waste reduction rather than seeing it as a threat. Overall, the pressure associated with siting difficulties has probably played a positive, indirect role in stimulating interest in waste reduction by industry and the public.

Most States promote waste reduction by focusing on information transfer and technical assistance. Most activity is directed at small businesses although they may be responsible for only a fraction of hazardous wastes generated. Few attempts have been made or systems developed to document the effects State programs have had on waste reduction. This lack of attention to measuring effectiveness is understandable, given the recent startup of programs and their limited resources. Moreover, State programs are but one of a number of factors affecting waste reduction plans and actions. In OTA's survey of industry about 10 percent overall (about 17 percent for small companies and 6 percent for large firms) indicated that State programs had affected their waste reduction efforts.

The limited promotion of waste reduction at the State level reflects constraints on waste reduction nationwide. Clearly there is no broad consensus yet at either the State or Federal level on the primacy and near-term feasibility of waste reduction. Waste reduction is not yet perceived as being on a par with or as necessary as existing regulatory programs. **Those administering pollution control programs often feel uneasy about the prospect of government shifting priority and resources to waste reduction. Waste reduction is viewed by some as antibusiness, chiefly because of its perceived potential for thwarting waste management siting attempts or leading to burdensome regulations.** These problems result from the fact that most people see waste reduction solely as an alternative environmental solution and not as a broadly applicable means of improving industrial efficiency and encouraging industrial growth. So far, few people view waste reduc-

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[33] J. Ward Wright, *Managing Hazardous Wastes*, The Council of State Governments, 1986, p. 61.

[34] Waste reduction is not singled out for attention in the National Governor's Association, "Policy Positions 1985-86." One component of waste reduction is briefly acknowledged within the policy section on siting: "*[s]ubstitution of nonhazardous chemicals*, incineration, and new treatment technologies can all contribute to decreasing the need for disposal capacity" [emphasis added].

Table 1-3.—State Programs With Waste Reduction Activities

State: Program name and/or coordinating body	Program components	Annual budget[a]	Waste reduction as percent of activities	Notes
California:				
Waste Reduction Unit (Alternative Technology & Policy Development Section of Department of Health Services)	Research grants Technical assistance	$1.5 million	<25	$1 million of funds used for grants
Connecticut:				
Office of Small Business Services (Department of Economic Development)	Technical assistance Loans	$50,000	<10	Lost $10,000 in funding for 1986-87
Georgia:				
Hazardous Waste On-Site Consultation Program (Georgia Tech Research Institute)	Technical assistance	$220,000[b]	10-15	Primarily compliance assistance to SQGs
Illinois:				
Hazardous Waste Research & Information Center	Research Technical assistance	$1.3 million	10	Most of funds for research on hazardous waste problems
Minnesota:				
Minnesota Waste Management Board	MnTAP Research grants Governor's Award	$235,000	25	Also has summer engineering student intern program
New York:				
Industrial Materials Recycling Act Program (NY State Environmental Facilities Agency)	Technical assistance Industrial financing	$494,000	<25	—
North Carolina:				
Pollution Prevention Pays	Technical assistance Challenge grants	$590,000[b]	>50	Multimedia focus
North Carolina Board of Science and Technology	Research and Education grants			
Governor's Waste Management Board	Governor's Award			
North Carolina Technical Development Authority	Financial assistance			
Pennsylvania:				
PennTAB (operated by Penn State University; funded by Department of Commerce)	Technical assistance	$150,000[c]	<50	2 of 12 staff handle environmental assistance
Tennessee:				
Safe Growth Cabinet Council	Governor's Award	$1.8 million[b]	>25	$1.7 million of funds for University of Tennessee research program
Department of Economic and Community Development	Technical assistance			
Center for Industrial Service (University of Tennessee)	Hazardous Waste Extension Service			
Waste Management, Research & Education Institute (University of Tennessee)	Engineering research and development, policy research			
Wisconsin:				
Bureau of Solid Waste	Information outreach Research grants Tax exemptions	$850,000	<25	Only about $150,000 will be available in fiscal 1986-87

[a] 1985-86 unless otherwise indicated.

[b] EPA source of some/all funds.

[c] Estimate, based on staffing level for environmental assistance.

SOURCE: Office of Technology Assessment, 1986.

Box 1-G.—The North Carolina State Program

North Carolina's Pollution Prevention Pays Program is unique in that *it is a multimedia program* that addresses toxic materials, water and air quality, and solid and hazardous wastes. *It focuses largely, but not exclusively, on waste reduction.* The program's current annual budget totals $590,000 and contains both State and Federal funds.

The original idea for the program in North Carolina came from local environmentalists and was proposed as an alternative to land disposal of hazardous wastes. A number of State officials who recognized the need for a multimedia approach then played key roles in the development of the program and the building of consensus among members of the State legislature, State regulatory officials, industry, and other environmentalists.

Despite wide support for the program, expansion of its role in the near future is constrained by overall budget concerns of the State. Any budget increases that are available for environmental issues will go to the regulatory programs. The program considers an increase in its technical assistance staff—to allow for more onsite consultations—its most critical need.

So far, the program has documented the number of firms it has assisted and the types of projects that have ensued. It has developed one of the largest libraries and published the best bibliography on waste reduction and recycling. It is not known yet, however, whether the program's activities have contributed to a reduced need for land disposal facilities or improved the environmental condition of the State.

Technical Assistance.—In its first year of operation in 1985, technical assistance was conducted primarily by dealing with telephone calls. Five onsite visits were managed in the last half of 1985, and the program hopes to average one a month in 1986. An information clearinghouse has been developed that includes a library of relevant literature and the capability to conduct data searches through a variety of databanks. An in-house database is now being developed that will include literature, case studies, contacts, and program publications. Outreach consists of presentations by the program staff to trade associations, professional organizations, citizen groups, universities, and industry workshops.

Research and Education.—Through Research and Education Grants funded through the North Carolina Science and Technology Board, the program promotes research projects and develops educational tools. Research grants were first awarded to 13 university projects in 1984; grants were awarded in 1985 for 11 projects. A third round of 15 awards were made in 1986. Of these 15 projects, 11 deal with waste reduction.

Financial Assistance.—The program's ability to provide financial assistance comes primarily from its Challenge Grants. They are given to small businesses and communities for the development and implementation of waste reduction and recycling projects that are transferable to other firms or communities in North Carolina. Funding totals about $100,000 each year and is provided by the State and an EPA grant. The maximum for a Challenge Grant award is $5,000, and the amount awarded must be matched by the awardee. The money cannot be used for operating or capital costs or detailed engineering design. Sixteen projects were awarded in 1985 and 13 in 1986. Of the recent group, nine are waste reduction projects.

tion as contributing to safe and publicly acceptable industrial development. Many more people may do so as the economic and industrial benefits of waste reduction become better understood.

POLICY OPTIONS

The major obstacles to increased waste reduction are institutional and behaviorial rather than technical. Economic considerations are not an intrinsic impediment to waste reduction; rather, there are hurdles or barriers to overcome before short- and long-term economic benefits can be realized by waste generators. For example, 3M has concluded:

> The initial investment for a pollution prevention project may be higher in some cases than the cost of installing conventional pollution removal equipment. However, the annual operating and maintenance cost of the removal equipment will almost always make the total cost of this technology higher than the total cost of preventing pollution at the source.[35]

This does not mean that all waste reduction measures are economically equal. On the contrary, as a waste generator increasingly implements waste reduction and moves away from simple approaches, capital costs and the uncertainty about effectiveness may increase. Some government policies, therefore, will be more effective for generators who are just beginning to reduce waste, while others are more important for sustaining long-term waste reduction.

Of paramount importance is how people and organizations perceive the need for waste reduction, how they evaluate a full range of methods for its implementation, how they make a decision to proceed, and how they are rewarded. Considering that there has been no major public debate on Federal waste reduction policy, it is not surprising that there is not yet a consensus on what the congressional role might be in stimulating greater levels of waste reduction.

There are significant, broadly perceived problems with the current pollution control regulatory program, and remedies to improve environmental protection are often directed toward making the regulatory program more effective. Developing more comprehensive regulations or instituting stronger enforcement are the most commonly voiced suggestions, and both are sound approaches. **But the current regulatory system can be strengthened *and* waste reduction can be pursued.** The choice should not be seen as one between pollution control and waste reduction. For those who see a hazardous waste crisis as a major environmental issue,[36] waste reduction is increasingly accepted to be the most important part of the solution. But effective pollution control regulations will always be necessary.

Almost all of the Federal environmental statutes have offered some opportunities to pursue a waste reduction strategy (see ch. 5), but these opportunities have not often been taken. No environmental protection strategy based on pollution prevention has been developed within the larger pollution control framework. Pollution control continues to be the attractive route because people in industry and the regulatory agencies believe that end-of-pipe techniques are easier and more practical to apply than waste reduction, and when pollution problems were first identified this was probably the case. Now, however, prevention is more effective than control.

There are many opinions voiced about waste reduction, but one fact is incontrovertible: public policy on the issue, which is in its earliest—and perhaps most critical—stage of development, cannot rest for reinforcement on a body of detailed information. Straightforward big picture questions about waste reduction cannot at this time be answered quantitatively or even semiquantitatively. Answers to questions such as "How much waste reduction has industry accomplished on its own?" can now only be answered with subjective impressions or with examples that sound significant but may be atypical. **There is more talk about waste reduction by those who are not responsible for implementation than there is by those in industry, and industry people should be the source of detailed information. However, the lack of detailed information does not prevent our drawing certain important conclusions on the basis of logic, common sense, and qualitative information.**

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[35] M.D. Koenigsberger, paper presented at the Governor's Conference on Pollution Prevention Pays, Nashville, TN, March 1986.

[36] Public opinion polls have consistently revealed very strong and widespread concerns about hazardous waste. For example, in May 1986, the Harris Poll announced that 92 percent of the American public consider hazardous waste disposal a serious concern.

It is also difficult to evaluate the costs of certain types of policy actions because of the virtually innumerable technical ways to reduce waste. For example, direct economic incentives or financial assistance, if offered, might be used by nearly all industries for a host of actions despite the fact that these actions vary remarkably in their waste reduction intensity. It is not obvious what criteria could be used to limit access to direct government assistance, and some limitations would have to be set, as for any Federal financial support program.

Relatively low cost, unintrusive government actions based on persuasion, assistance, incentives, and education seem the best route to pursue at this time. Both State and foreign waste reduction programs appear to have adopted this middle course between a totally voluntary approach and a prescriptive regulatory one. Considering the limited Federal leadership to date, it can be argued that almost anything the government does to foster waste reduction should be viewed as potentially effective. Certain kinds of Federal actions, however, that require large spending or put industry at risk may have difficulty receiving broad support *at this time*. All this may change, however. **If an informed public, greatly concerned about hazardous waste, becomes convinced that industry is lagging in reducing waste, then it will call for more prescriptive and costly Federal initiatives.**

OTA has not examined all possible policy options. Three major options have been formulated and are briefly summarized below. (See ch. 2 for the detailed policy analysis.) Some actions from each option might be combined as they are not necessarily mutually exclusive. The choice of the three strategically different options has been made to clarify for Congress the range of distinctly different choices that can be considered. **Regardless of what course Congress pursues, waste reduction *must* be unambiguously defined so that industrial efforts are channeled away from traditional waste management to true waste reduction.**

Policy Option I: Maintain Current, Limited Voluntary Program

Under this option, no new Federal waste reduction initiative would be taken, with the exception of making some effort to obtain reliable information on the current extent and pace of waste reduction. For the most part, this option is a market driven approach. The premise is that what the Federal Government is now doing is sufficient to allow the marketplace to operate efficiently. Primarily, this means letting the indirect economic incentive of the pollution control regulatory system function.

This option is not a true no action option because it requires strong congressional oversight of existing environmental programs. It is undisputed that a well-enforced pollution control regulatory system acts as an important incentive for some waste reduction efforts when waste reduction is chiefly a voluntary effort by industry. Moreover, congressional oversight—if linked to waste reduction—could catalyze widespread public scrutiny and lobbying that might make the marketplace move vigorously toward waste reduction. (The public can play this role, of course, with either of the other two options as well.) Another limited action by Congress or EPA that would be necessary for this option is collecting reliable, systematic data on the extent of waste reduction that is now taking place nationwide. Consistent with the basic character of this option, however, information gathering would be achieved through a study rather than through comprehensive collection of data from all or most waste generators.

The chief advantage of this option is that it imposes no new major costs on government or industry. Harmful impacts on troubled industries are not likely to occur as companies would decide individually what waste reduction methods to implement. Its chief weakness is that relying on the indirect incentive of rising waste management and regulatory compliance costs can be ineffective. Companies may not have the technical and economic resources to respond to the incentive, and if they do respond it may not be with waste reduction efforts. In addition, the incentive may not apply to companies where those costs are small relative to overall production costs. **Various congressional and regulatory actions may reduce or confuse the perceived incentive by, for example, promoting pollution control rather than waste reduction.** In general, gauging the likelihood that the marketplace will respond to indirect incentives is a complex matter. There is substantial inertia in the existing system. In theory the marketplace may be responding, but in practice that response can be slow and uneven. Moreover, this option would not address the deficiencies and limits of the existing national waste reduction effort with regard to multimedia coverage. For example, non-RCRA and unregulated hazardous wastes may not receive major attention by waste generators, who are accustomed to defining hazardous wastes only as the government has defined them under RCRA.

This option is attractive to those who want to maintain the voluntary approach to waste reduction and initiate the least possible amount of government activity until there is more evidence of insufficient waste reduction.

Policy Option II: Change and Expand Existing Programs

A number of actions are possible that could affect, either directly or indirectly, the extent and pace of waste reduction in industry. **The actions included in this option can build on existing, familiar government programs and policy approaches.** Most of what the government now does relative to hazardous waste falls under the stick rather than carrot approach; the following possible actions reflect this choice:

1. modify and strengthen the existing RCRA waste minimization reporting and planning requirements,
2. adopt similar reporting and planning requirements for the other major environmental programs,
3. use waste reduction impact analysis for regulatory actions,
4. initiate a periodic chemical survey of industry,
5. mandate amounts of waste reduction in wastes and processes to be achieved by industry,
6. tax all wastes and possibly offer rebates for those who have reduced wastes substantially or who will do so,
7. establish a waste reduction R&D program in EPA, and
8. change government procurement policies to facilitate waste reduction.

The chief strength of this option is that it would provide strong government action that would shift waste reduction from a voluntary effort to something closer to what now exists for pollution control. Its chief weakness is that, based on historical experience, it is likely to be ineffective in achieving rapid and comprehensive waste reduction by using the existing, predominantly pollution control system. Also, harmful economic impacts on U.S. industries might result from overly burdensome or inflexible requirements.

This option is most attractive to those who want to move faster with government requirements for waste reduction than the voluntary approach permits, but who want to do so without establishing major new programs.

Policy Option III: A New Highly Visible Waste Reduction Program

The fundamental criterion for this option is the primacy of waste reduction (as defined in

this report) over pollution control. Exercising this option would be tantamount to establishing a new waste reduction ethic for American society. Another premise of this option is that existing environmental statutes and programs will not do the job as proven by the unsuccessful attempts to include pollution prevention in pollution control programs. This option emphasizes Federal assistance and direct incentives to *spur* rather than *require* more waste reduction. But certain Federal requirements would necessarily be placed on generators. **The goal would be to elevate waste reduction to a level comparable to that of pollution control.** While few new responsibilities would be added to existing EPA programs, several new programs would be created to give unambiguous and unequivocal Federal support and commitment to the primacy of waste reduction over waste management. Possible actions under this option are:

1. establish a grants program to fund a variety of activities that support industrial waste reduction, such as technical assistance and generic R&D (funding would not be available for specific waste reduction efforts by individual companies);
2. enact new waste reduction legislation based on the multimedia concept, with expanded Federal reporting and planning requirements for industry;
3. establish reporting requirements on waste reduction for financial reports to the Securities and Exchange Commission;
4. create a new EPA Office of Waste Reduction with an Assistant Administrator;
5. allow regulatory concessions, i.e., trading off certain limited pollution control regulatory requirements for waste reduction achievements; and
6. create independent State Waste Reduction Boards to implement many of the new Federal initiatives.

The chief strength of this option is that it would stimulate and assist rapid, multimedia, comprehensive waste reduction. This option depends on Federal leadership in the forms of institutional attention, assistance, and educational efforts, rather than on regulatory requirements. Its major disadvantage is that more institutional change would be necessary, and this raises problems about implementation.

This option is most attractive to those who want to see waste reduction given strong Federal support and a very high priority—and who also would like to see Federal policy implemented as much as possible at the State level.

Comparison of Policy Options

There is a need to clarify national policy on waste reduction, including the matter of its primacy over waste treatment and disposal, as part of any congressional debate on various waste reduction policy options. **Attention to the problems of defining and measuring waste reduction is also critically needed, no matter which course Congress pursues. Federal initiatives on waste reduction could, for example, be ineffective if a definition of waste reduction includes waste treatment.**

If the Federal public policy goal is **rapid and comprehensive** hazardous waste reduction, then the option most likely to attain that goal without harm to American industry is Policy Option III. This option strikes a middle course between a voluntary approach with minimal Federal involvement (Policy Option I) and a more traditional, prescriptive, regulatory one (Policy Option II). Policy Option III explicitly recognizes the significant effects on waste reduction of other public and private efforts (i.e., State and local programs and those of insurance and financial companies and environmental groups).

This conclusion hinges, in part, on the observation that current data inadequacies make it difficult to justify, design, and enforce a more prescriptive Federal approach at this time. Certain actions contained in Policy Option II could be combined with some or all of the actions in Policy Option III without changing the basic character of Policy Option III. These include: waste reduction impact analysis for regulatory actions, a periodic chemical survey of industry, a waste reduction R&D program within EPA, and changing Federal procurement policies to facilitate waste reduction. Even if Policy Option III were implemented, in whole or in part, information eventually obtained might set the stage for later adoption of Policy Option II.

It is not yet clear, however, whether the above goal is the current Federal public policy goal. Other options may therefore merit serious consideration, either now or in the future. **While the current statement of national policy, as given earlier, is an important affirmation of the importance of waste reduction, it does not explicitly address the issue of comprehensiveness (i.e., multimedia coverage). Nor does it address the possibility of Federal activities that could help generators overcome their site-specific impediments to waste reduction. The statement asks for expeditious waste reduction, but it does so from the perspective of the generator within a voluntary system. Consequently, there is a critical need for a full policy debate on waste reduction before specific actions are taken.**

Chapter 2

Policy Options

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Chapter 2

Policy Options

THE EXISTING FEDERAL EFFORT

Waste Minimization Under RCRA

The 1984 waste minimization amendments to the Resource Conservation and Recovery Act (RCRA) deal explicitly with waste reduction. In addition to their significance as the first major congressional policy statement on waste reduction, they have had some notable positive effects. Congress did not direct industry to carry out waste reduction. It requires that companies report what they are currently doing and what they are planning to do towards that goal. The result has been a more effective *voluntary* program than previously existed, with government requirements purposely kept unintrusive. Although Congress has imposed only minimal self-reporting and self-enforcing regulatory requirements, the amendments have unquestionably given more importance and visibility to waste reduction.

Some opportunities to achieve environmental protection through waste reduction were created within earlier environmental statutes, such as the Clean Water Act and the Clean Air Act, but the end-of-pipe pollution control approach became dominant. This history suggests that attempts to foster waste reduction as part of existing pollution control programs might not be effective (see ch. 5).

About 40 percent of companies surveyed by OTA (see app. A) say that they have initiated new waste reduction programs as a result of the 1984 legislation. Others appear to have a wait-and-see attitude. There is some reluctance on the part of industry to provide detailed data on their waste reduction efforts, even among those that publicize their successes. It is commonly believed that certain types of detailed information might be used in some way by government to set required amounts of waste reduction. Also, because of concerns about competitors, many companies keep some information confidential, particularly about their processes.[1]

A summary of the problems with the RCRA amendments that deal with waste minimization and waste reduction, the statute and regulations and their implementation by the Environmental Protection Agency (EPA) and the States, is given in table 1-1 in chapter 1. Compared to other aspects of the RCRA 1984 amendments, waste reduction has received relatively low priority. There is very little guidance to industry in the RCRA amendments as to what is the most desirable type of waste reduction, in terms of environmental benefits, and there is no provision for governmental assistance. Moreover, it is generally believed that the RCRA requirements apply narrowly to hazardous solid wastes as defined by RCRA and not to the full range of hazardous substances and pollutants that are currently unregulated or that are regulated by other environmental statutes and programs. On the basis of EPA actions to date, there is little reason to believe any other interpretation has been made.

A common misconception is that the solid, hazardous wastes covered by RCRA—roughly 250 million tons of these are generated annually[2]—represent most industrial hazardous waste. One attempt by EPA to summarize emissions of air toxics nationwide resulted in an admittedly uncertain total of over 4 million tons annually for 86 chemicals;[3] another EPA study estimated emissions of volatile organic compounds to be 19 million tons annually.[4] A recent study on waste reduction in the chemical industry found that:

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[1] For example, in a recent publication on environmental auditing (funded by EPA) the following appears: " . . . the auditor needs to be careful in how the information collected is recorded to avoid revealing information on production and manufacturing processes." [The Environmental Law Institute," An Introduction to Environmental Auditing," 1985.] Although there is increasing interest in audits for waste reduction, it must be emphasized that most current auditing is aimed at regulatory compliance and that people doing this job may not be qualified to examine production operations for waste reduction purposes.

[2] This figure for RCRA waste is widely used because EPA, OTA, and the Congressional Budget Office have obtained it through different techniques; however, a survey of about 50 percent of the Chemical Manufacturers Association's member chemical companies for 1984 indicated that 278.5 million tons of hazardous waste were generated by them alone. [Chemical Manufacturers Association, "Results of the 1984 CMA Hazardous Waste Survey," January 1986.]

> Despite the common assumption that solid waste generation far exceeds discharges to air and water, hazardous chemical wastes were found to be generated in roughly equal amounts as air emissions, wastewater discharges, and as solid wastes.[5]

Taking into account the lack of certainty of the RCRA data and rough attempts by EPA to calculate other wastes, it is still fair to estimate that for every person in the Nation well over a ton of hazardous waste is being generated annually.

While quantities by themselves do not determine environmental risk, they do indicate that there is a significant potential for problems, depending on local exposure conditions. In some cases there may be danger of global problems related to atmospheric effects. **Moreover, a national waste reduction program that does not deal with cutting down on pollutants specified under the Clean Air and Clean Water Acts would not be effective because some wastes might then be legally shifted to the air and the water.**

Another characteristic of the RCRA statute and regulations is the ambiguous tension it sets up between waste reduction (prevention) and preferred waste management (control). The statute seems to give primacy to waste reduction in its policy statement, but a main focus of the RCRA 1984 amendments is on alternatives to land disposal, and later sections of the statute and subsequent regulations give emphasis to the use of waste treatment. **The desired shift away from land disposal may take place within the framework of pollution control, specifically waste treatment, unless waste reduction is unambiguously given primacy over treatment and also given a clear definition that is consistent with this primacy**. As noted earlier, this is not meant to imply that this report deems waste treatment undesirable. The issue is whether the statute's intent is to require that waste reduction be examined fully prior to choosing waste treatment.

The statutory and regulatory term *waste minimization* can be misinterpreted and confused with waste reduction. It is a term that is more inclusive than *waste reduction* because it is often believed to give equal status to offsite recycling and waste treatment alternatives to land disposal. Are generators expected to reduce their RCRA hazardous waste, their wastes covered by other environmental programs, and their unregulated wastes? Unless Congress gives further attention to waste reduction's primacy and definition, the answer to these questions may be "where is it written?"—or, more succinctly—"no."

Other aspects of the 1984 amendments, particularly the limits they set on land disposal, can be viewed as adjuncts to the direct attempt made in the amendments to stimulate waste reduction; but it is too early to know how EPA will implement this intent. (Indeed, early signs are that EPA's approach is unlikely to be acceptable to Congress and environmental groups.) It is impossible even to guess what the quantitative impact of the amendments will be. Moreover, current Federal data collection systems will not be able to measure a waste reduction effect.

To sum up, the congressional attempt to deal directly with waste reduction has retained the voluntary approach and has had positive impacts by focusing more attention on waste reduction. However, **no actions have yet been taken to give waste reduction the institutional support and visibility of pollution control programs. Since no information is being collected or evaluated on how the voluntary approach works, some effort is probably required for this purpose**. Because of limited government requirements and the absence of information-gathering programs, the amount of comprehensive waste reduction at the plant level is uncertain and largely undocumented; nor is it clear that everything that is being done leads to environmental risk reduction. It is not possible to know whether examples and case studies of waste reduction are representative of industry practice. In other words, while there is some solid information on specific cases of waste reduction, there is no data on the *extent* of waste reduction nationwide. Companies surveyed by OTA believe publicized waste reduction efforts may be overstatements. The concern appears to be that reports of successes imply too much about the broad applicability of waste reduction. Poor and limited information fosters such skepticism.

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[3] Tom Lahre, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, "Characterization of Available Nationwide Air Toxics Emissions Data," June 13, 1984.

[4] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, "Control Techniques for Volatile Organic Compound Emissions From Stationary Sources," draft, July 1985.

[5] David J. Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985), p. 27.

Current EPA Plans

The Office of Solid Waste (OSW) at EPA is formulating a short-term (2 to 4 years) and a long-term (5 to 10 years) strategy.[6] The planning document is highly critical of the RCRA program, but waste minimization appears only in the long-term strategy. EPA says: "Waste minimization represents the long-run solution to many of [our] current problems and should be a major component of our long-run strategy." No distinction is made between waste minimization and waste reduction. A recent fiscal year 1987 draft priority list for all of EPA's activities makes no explicit mention of waste minimization/reduction in any of the four priorities listed under hazardous waste.[7]

EPA's Office of Research and Development (ORD) has described hazardous waste/Superfund issues for research for its 1988 budget request.[8] Waste minimization, or waste reduction, does not appear among the 14 areas identified. However, waste minimization does appear as one of six major areas in ORD's plans for its alternative (to land disposal) technologies program. Waste minimization, defined to include recycling but not waste treatment, has the lowest level of funding in this program, showing a proposed increase from 2.5 percent ($235,000) in fiscal year 1986 to a possible 4.1 percent ($440,000) in fiscal year 1989.[9]

Recent comments by one of EPA's Regional Administrators are also significant. With regard to the problems that impede waste reduction—regulatory loopholes, availability of low cost waste disposal, sporadic regulatory oversight, and fragmented and incomplete information—he said,

> . . . each one of them is being, or has been, addressed over the last two years by several Federal and State initiatives and, most notably, by the '84 amendments.

With regard to the need to take further action, he said:

> I don't think there's any shortage of indirect incentives to reducing waste at the source . . . there are direct regulations as well. The question seems to be whether these efforts will be enough. It's easy to see why more direct regulation of waste production seems an especially attractive option. The truth is we don't know if the current scenario of indirect regulation, including new components now in the works, will be enough to reduce waste output to acceptable levels. I honestly believe it will.[10]

This view is shared by ORD:

> Even without EPA regulations on waste minimization, there is considerable economic

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[6] U.S. Environmental Protection Agency, Office of Solid Waste, "Hazardous Waste Implementation Strategy," draft, 1986.

[7] *Inside E.P.A. Weekly Report*, Dec. 6, 1985.

[8] U.S. Environmental Protection Agency, Office of Research and Development, memorandum from the Hazardous Waste/Superfund Research Committee (Meg Kelly and John Skinner) to Donald J. Ehreth and J. Winston Porter, Apr. 23, 1986.

[9] U.S. Environmental Protection Agency, Office of Research and Development, memorandum "Alternative Technology Review (Step 2)," from Alfred W. Lindsey to the Hazardous Waste Research Subcommittee (J. Denit and H. Quinn), June 16, 1986. EPA's Science Advisory Board, in reviewing this research plan, recommended that funding for waste minimization efforts be increased and *that ORD expand the program to include evaluations in the area of process changes and material substitutions* (i.e., waste reduction). The board said that "true waste minimization" should begin to reduce or eliminate the generation of hazardous wastes *in the first place* through such steps. [U.S. Environmental Protection Agency, Science Advisory Board, "Review of the Alternative Technologies Research Program," report of the Environmental Engineering Committee, July 1986.]

[10] Christopher J. Daggett, speech given at *Waste Reduction: How To Make It Happen* symposium, New Jersey Institute of Technology, Mar. 12, 1986.

> incentive for industry to minimize, reuse, or recycle hazardous wastes.[11]

At roughly the same time, however, the Office of Solid Waste, which implements RCRA, said:

> . . . the current regulatory structure is complex and does not provide sufficient incentives for better waste management.[12]

If there are insufficient incentives for better waste management, there are certainly insufficient incentives for waste reduction.

Even after the recent reorganization of OSW, waste minimization/reduction was given no significant status within EPA's organization, although this is inconsistent with the concept that it is the first option to consider in dealing with hazardous waste. Waste minimization/reduction is the responsibility of EPA's Treatment Technology Section (one of six sections), which is within the Waste Treatment Branch (one of three branches), which is within the Waste Management Division (one of five offices and divisions) of the Office of Solid Waste (one of three major components) headed by the Assistant Administrator for Solid Waste and Emergency Response. In a description of OSW's new organization, 32 functions of the Waste Management Division are given. The only reference to waste minimization/reduction is found in the description of the last (32nd) function.

OTA concludes that there is no indication that EPA is planning to give waste reduction major attention in the near term. Organizationally as well as ideologically, the status of waste reduction at EPA is consistent with the subject's historical subordination to pollution control.

CONGRESSIONAL POLICY OPTIONS

The major obstacles to increased waste reduction appear to be more institutional and behavioral than technological. There is no intrinsic economic disadvantage to waste reduction. As an executive of Du Pont said:

> Reduced waste will inevitably lead to lower cost for products, and thus, a higher standard of living for all Americans. . . . It will not be the law, per se, that will fuel waste minimization efforts, but rather the basic economics of good waste management.[13]

There are, however, economic hurdles or barriers that often must be overcome before short- and long-term economic benefits can be realized. As is explained in chapter 3, the status of our basic science and technical development does not appear to be a major limiting factor for most waste reduction activities. What is of greater importance is how people and organizations perceive the need for waste reduction, how they define waste reduction, how they evaluate a full range of technical ways to reduce waste, and how they decide to implement their decisions.

Based on findings from its analyses, surveys, and workshops, OTA agrees with other studies and perceptions that much more waste reduction is technically and economically feasible. But because waste reduction is an ongoing activity which is responsive to many conditions in industry and to government actions, it is not at all clear what the congressional role is or might be in attaining greater levels of waste reduction nationwide. Many people look to waste reduction as a solution to what they fear is a hazardous waste crisis in this country, but others emphasize changing the current regulatory program within the pollution control framework (e.g., better enforcement and more regulations). Still others fear that the crisis may be defined away, if, for example, EPA redefines hazardous waste so as to greatly reduce the universe of materials regulated. In the roster of potential problems the possibility of a new and poor definition of waste reduction ranks high.

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[11] U.S. Environmental Protection Agency, memorandum, "Alternative Technology Review (Step 2)," op. cit.

[12] Gary M. Katz, Director, Management and Organization Division, U.S. Environmental Protection Agency, memorandum on "Reorganization of the Office of Solid Waste," to Howard M. Messner, Assistant Administrator, May 7, 1986.

[13] J. Howard Todd, "Waste Reduction . . . Industry's Challenge," paper presented at Lindbergh Symposium on Environment and Technology, Orlando, FL, February 1986.

OTA has structured the congressional policy possibilities by defining three major options:

- **Option I: Maintain Current Program**. Current, limited voluntary program is maintained.
- **Option II: Improve Existing Programs**. Existing regulatory structure is changed and expanded.
- **Option III: New Strategy**. A new, highly visible waste reduction program is initiated.

These three different options have been made to help Congress clarify the distinctly different choices it has, including the first option of not taking any new action. However, certain specific activities listed for Options II and III might be transferred from Option II to III or vice versa or be eliminated. The three options have been defined to concentrate the discussion on major strategic choices for Congress, rather than to provide a blueprint for exactly how each of the action options (II and III) could be carried out.

Each of the options is discussed below. A comparative analysis follows to clarify the advantages and disadvantages of each option and to show how each option is compatible with a major policy objective.

Policy Option I: Maintain the Current Limited Voluntary Program

The premise behind this option is that it may be unnecessary for the Federal Government to go beyond the 1984 RCRA reporting requirements on waste minimization in order to stimulate waste reduction. This option can be thought of as a market-driven approach. Although no new major action, such as establishing requirements for waste reduction or offering direct incentives and assistance, would be taken, this option is **not** a no action option.

First, a strong case can be made about the *imperative* to maintain a well-enforced pollution control regulatory system. An important condition for promoting more waste reduction under Option I, therefore, would be to implement and enforce existing pollution control regulatory programs vigorously. Congressional oversight would be critical. Industry says that there are two important driving forces for waste reduction: 1) Congress' direction to EPA to encourage the use of land disposal alternatives, which would drive up waste management costs; and 2) Superfund's requirements that increase costs to generators for the cleanup of toxic waste sites. Yet there is uncertainty about legislative changes and implementation of statutes concerning these critical factors.

Effort is badly needed to gather better information on current waste reduction. In Option I, this imperative could take the form of a study rather than of comprehensive reporting of data by all or most waste generators.

The following arguments support the position that Congress not take any further major action on waste reduction:

- It is too early to conclude that the existing program is either ineffective or too limited in scope.
- There are an increasing number of statements and examples from companies testifying to their interest in and successful implementation of waste reduction programs.
- All the circumstances that are limiting the use of land disposal will continue to increase the cost of all waste management options and provide more incentives for waste reduction.
- The continuing effort to clean up uncontrolled hazardous waste sites under the Superfund program and by the States and industry will increase apprehension about costly liabilities associated with waste generation and management and, hence, motivate more companies to emphasize implementation of waste reduction.
- There is every reason to believe that the successful efforts of industry will be multiplied many times as effective techniques and expertise are transferred more broadly within companies and industries.
- In many large, decentralized corporations the waste reduction policies and programs

established by senior management are just beginning to be implemented at the plant level.

- There are signs that companies, including some waste generators, will find it profitable to develop and sell proven waste reduction technologies to others and to provide assistance to waste generators. A parallel case can be drawn here to what has occurred in the energy conservation area.
- Increasingly, companies will find it profitable to sell new or reformulated raw materials and products which result in waste reduction in the industrial operations of their clients.
- Existing and new State and local waste reduction efforts and such related activities as waste-end taxes and chemical surveys will have increasing positive effects, particularly for smaller companies.
- The implementation of existing environmental regulatory programs may promote waste reduction.
- General Federal budget circumstances as well as problems in many manufacturing industries do not favor initiating a major new Federal program which would cost government and industry significant sums.
- There are signs that insurance companies and financial institutions may provide incentives for more attention to waste reduction.

Some people believe, for all or many of these reasons, that no further major congressional action is necessary for dealing with waste reduction. (These same reasons may also be used to support Federal actions that are not of a prescriptive nature, as in Option III.) Others look to the future and argue that the environmental benefits of widespread and substantial waste reduction are more certain and potentially larger than those that will accrue from the pollution control approach and conclude, on this basis alone, that the government should be directly supportive of waste reduction. Given the past record of regulatory ineffectiveness and uncertainty, they believe that a more dedicated waste reduction effort by the Federal Government is necessary. Specifically, there are three major concerns about whether Option I would result in comprehensive waste reduction.

First, **a fundamental disadvantage of this option is that there is no assurance that the indirect incentive of the cost of waste management and compliance with regulations does indeed work to promote waste reduction.** The existence of an indirect incentive does not guarantee that it will lead to the desired effect.

There is no reason to believe that all or most generators have the technical and economic resources to respond effectively even if they perceive the incentive. Actions that require capital investment may be difficult to take, even though eventually the economic payback will be substantial. Relying on the marketplace to operate efficiently clouds significant noneconomic factors, such as uncertainty as to whether the companies have the technical personnel and information to reduce waste. Nor is it certain that there will be organizational priorities which favor waste reduction over competing economically advantageous options.

Whether there is an incentive depends on the economics of a generator's business; for some generators the costs of waste management and regulatory compliance are not a large enough fraction of their costs to warrant attention to or investment in waste reduction. Poor enforcement, low regulatory compliance, and regulatory loopholes may also lower incentives for reducing certain wastes.

Various congressional and regulatory actions reinforce pollution control options rather than waste reduction and can send confusing messages to waste generators. Significant numbers of companies still have a wait-and-see attitude.

Second, **a major problem with the current effort is that waste reduction actions are not likely to be multimedia in character**. Reduction carried out in the current voluntary framework under RCRA might overlook wastes that are of considerable environmental importance; this is especially true of toxic air emissions. The piecemeal development of environmental programs and the lack of multimedia integration, moreover, have in some instances resulted in cross-media transfer; that is, what is deemed a successful environmental program can involve the shifting of waste from one medium to another, less regulated environmental medium. It does not result in destruction of waste.

Third, those who are critical of this option also note that **it is impossible to know if waste reduction activities now in effect have concentrated on the most hazardous wastes** since Federal regulatory programs have done little to distinguish degrees of hazard among wastes and pollutants. (See OTA's *Technologies and Management Strategies for Hazardous Waste Control*, 1983.) Recognition of the fact that current regulatory programs have many loopholes, move slowly, and are deficient in enforcement may also misdirect waste reduction efforts. In the absence of Federal guidance, waste reduction may result in no, or very limited, environmental protection. It is often difficult to evaluate reports of waste reduction success stories in terms of environmental protection.

More specifically, Option I may be rendered ineffective because of the following aspects of the current Federal effort:

- The narrow approach of the current waste minimization requirements with regard to what wastes are covered inevitably means that many harmful wastes are not going to be addressed. Wastes not subject to reduction could be increasingly generated and might be put into the environment because of cross-media transfers.
- The lack of clarity with regard to the primacy of waste reduction is likely to mean that many companies will elect instead to use waste management approaches.
- Because of the lack of guidance to industry as to what the term *waste reduction* really means and what it is designed to accomplish, much of the waste reduction that is technically feasible may not occur and that which does take place may result in less environmental risk reduction than is feasible.
- The lack of enforcement of existing pollution control requirements means that many companies may not meet these requirements.
- The lack of a database or an attempt to create one means that the government and the public may never know whether the current approach is successful.
- Regulatory requirements for pollution control are likely to continue to increase, making it difficult for companies to divert resources to waste reduction in order to respond to the indirect incentive of rising waste management and regulatory compliance costs.

It is sometimes suggested that no new major Federal initiative is necessary because some States have already established nonregulatory waste minimization efforts which include waste reduction. These initiatives originated, for the most part, prior to 1984 and the beginning of limited Federal action under RCRA. However, none of the State programs are well funded, all are relatively new, and their effectiveness in terms of waste reduction cannot be assessed (see ch. 6). Many of the State programs do not focus on waste reduction. For these reasons, current or planned State waste reduction programs, which may be quite successful in dealing with State goals, are unlikely to have a substantial effect on waste reduction nationwide. Yet the State programs are undoubtedly effective to some extent, and they do provide useful information on how a Federal effort might be structured.

Perhaps the most difficult choice for Congress is whether to take any further action in the near future on the waste reduction issue. The key uncertainty about maintaining the current program and relying on the marketplace to operate efficiently has to do with the *pace* of waste reduction and the extent to which it is *comprehensive* with regard to wastes and industries. Those who favor not taking any new Federal action may be correct in believing that *ultimately*—perhaps in some decades—the level of waste reduction might be the same with or without further specifically targeted government action. However, even if this view is correct, Federal action to spur waste reduction could matter in the near term; more effective environmental protection achieved at an earlier time has environmental and probably economic benefits. **OTA concludes that if rapid and comprehensive hazardous waste reduction is the Federal public policy goal, then this option is not likely to be effective.**

Policy Option II: Change and Expand Existing Programs

In defining this option OTA has assembled a number of possible actions which might be taken by Congress. They share one important characteristic: they alter or expand the current pollution control regulatory framework but they do not change its character. This option has been designed to suggest ways that Congress could build on the existing environmental statutes and programs and the traditional means of achieving environmental goals. The assumption behind this option is that to reduce more waste the current system has to be modified. There are many actions that could either *directly* or *indirectly* affect the extent and pace of waste reduction in industry. OTA has focused on several major activities for this option:

1. modify and strengthen the existing RCRA waste minimization reporting and planning requirements,
2. adopt similar reporting and planning requirements for the other major environmental programs,
3. use waste reduction impact analysis for regulatory actions,
4. initiate a periodic chemical survey of industry,
5. mandate amounts of waste reduction to be achieved by industry,
6. tax all wastes and possibly offer rebates for those who plan to reduce wastes substantially or have done so,
7. have EPA do waste reduction R&D, and
8. change government procurement policies. (Unlike the above, this last action is not related to the current environmental regulatory system.)

These activities can be implemented singly or in any combination, and some could be transferred to Option III.

Modify and Strengthen the Existing RCRA Requirements

The current statute is ambiguous and Congress could clarify legislatively that, in the hierarchy of options available to industry, that of not generating hazardous waste in the first place should rank highest. Congress could also provide a clear definition of waste reduction. There is also a need to address problems in EPA's regulations, their implementation, and enforcement which result in a weakening of the indirect incentive to reduce waste; this could be accomplished through congressional oversight.

Another type of action would be to *require* RCRA waste generators and those who need permits for treatment, storage, and disposal facilities to demonstrate their commitment to waste reduction. First, regulations could be established for the submission of detailed waste reduction reports including data which demonstrated the extent of waste reduction carried out and *plans* to which the company is committed, including specific goals against which progress will be measured. Criteria for evaluating waste reduction plans could be established by Congress legislatively. For example, generators could be required to provide technical justification for choosing specific wastes for reduction from among those generated, to give a schedule of the actions to be taken to reduce or eliminate these wastes, and to submit a long-term schedule that establishes when other wastes will be addressed. (See ch. 3 for a more detailed discussion of the considerations appropriate for such a plan.)

Another possibility would be to require that waste reduction plans by generators be certified by professional engineers analogous to the way certified public accountants give professional certification to financial reports. This would address the problem of implementation that arises in regulatory agencies where not enough people of the appropriate kind would be available to evaluate such plans. Environmental engineers and consultants are not necessarily the best equipped people to deal with the production process in which waste reduction opportunities exist. Perhaps displaced or retired engineers with experience in manufacturing might be given special training to obtain certification as waste reduction auditors.

Second, the submission of waste reduction reports and planning information could be made a condition for obtaining new or renewed RCRA permits. This would increase the need to expedite review of such plans.

Third, fines and penalties similar to those now levied in cases of noncompliance with major RCRA regulations could be applied to waste reduction planning and information requirements.

The advantage of this action is that it establishes Federal waste reduction regulations within the RCRA framework and moves from the largely voluntary state that now exists to a required, focused waste reduction activity.

The chief disadvantage is that past experience indicates that EPA and the States would have limited ability to analyze and assemble the information collected and to enforce the requirements.

Require Waste Reduction Reporting and Planning in the Air and Water Regulatory Programs

Similar to the above three regulatory requirements and actions that might take place within the context of RCRA, Congress could introduce reporting and planning requirements in the programs established under the Clean Air and Clean Water Acts. However, these programs differ in many respects from the RCRA program. For example, the air and water programs generally allow hazardous waste to be released into the environment within certain set limits. Consequently, to require companies to cut back on the generation of what are now legally allowed releases is likely to be construed as a much more radical measure than action under RCRA, which does not regulate the *amounts* of waste that can be generated. Another complexity would be that waste reduction, defined broadly, would include many wastes not currently being regulated under the air and water programs. Some might argue that if the government is unable to set safe limits for a specific waste in the environment, it has no basis for deciding that a waste must be reduced because of the hazards it presents. If this dilemma arose, there might be pressure to limit waste reduction mandated under the Clean Air and Clean Water Acts to those wastes for which limits have been set for discharge into the environment.

Requiring reporting and planning for waste reduction under the air and water programs poses substantially greater, but not necessarily insurmountable, legislative challenges than would be the case under the RCRA program. Moreover, concerns would be likely to arise about the implementation of waste reduction requirements under the air and water programs. There have been substantial delays in a number of areas, particularly in the regulation of toxic air emissions and the establishment of pretreatment standards for discharges to water treatment plants. Adding waste reduction requirements might divert attention away from pollution control needs. The experience so far under the RCRA program suggests that waste reduction might have a relatively low priority in any existing program at EPA.

Waste Reduction Impact Analysis

An important way to promote waste reduction would be to require that any proposed regulatory action by EPA be accompanied by analysis of its potential impacts on waste reduction. Such analysis would be similar to what is now done, for example, for the economic impact of regulatory actions on industry. There are several reasons for believing that such a measure would be effective. First, it is clear that regulatory programs have a substantial effect on actual and future waste management costs and liabilities and that this influences *some* decisions about waste reduction. Second, there is no reason to believe that current regulatory actions are seen or evaluated from the perspective of waste reduction.

For example, an action under RCRA that maintained the viability of lower cost waste management options such as landfills, or one under Superfund that reduced the scope or magnitude of waste generators' liabilities, would reasonably be expected to reduce the motivation for waste reduction. Other types of actions can have even more direct effects, such as determining that some wastes become regulated or that others become delisted.

Just performing such analyses would focus attention on waste reduction and might flag actions whose benefits are too limited to offset a significantly negative impact on waste reduction. The fact that such impact analysis might be possible to perform only qualitatively would not necessarily reduce its usefulness. This is the type of measure that affirms the priority of waste reduction.

A Federal Chemical Survey

This would be a program that would require an industrial plant to report all of its waste generation, emissions, and discharges for a broad range of hazardous substances into all environmental media. It could either be an addition to or an alternative to expanded reporting requirements discussed previously in the context of current environmental programs and would include unregulated hazardous substances as well as those now regulated under one or more environmental statutes.

Such a chemical survey would be a form of mass balance analysis which details process inputs and the known or anticipated outputs of hazardous chemicals for a specific plant in terms, for example, of tons per year. However, the link to waste reduction is indirect unless data are obtained for specific processes and the data put on a production output basis.

A Federal chemical survey has already received attention within the framework of congressional reauthorization of the Superfund program.[14] It has been given a high priority by some, particularly environmentalists, who feel that the information that would be obtained from such a national survey: 1) is critical to an effective environmental protection program, 2) will inevitably be needed by industry to comply with pollution control and waste reduction requirements, and 3) will provide facts that the public has a right to know. Several States, including New Jersey, New York, and Maryland, are conducting or have conducted chemical surveys, but there has been no long-standing program. Existing surveys have not been designed to measure waste reduction, and because data are not obtained on a process and production output basis they are not able to do so.

State chemical survey programs have intrinsic problems. A recent report made the following comments about New York's Industrial Chemical Survey, which was initiated in 1983:

> While the Survey is an invaluable source, the public still cannot obtain information which a company has classified as a trade secret or which it claims will impair present or imminent contract awards or labor negotiations. Outdated information is another complication since only those industries needing a permit or renewal from DEC to discharge hazardous substances or to dispose of solid wastes have to submit updated chemical inventories—and then sometimes at intervals of three to five years. While most of the State's larger companies have responded, thousands of companies still have never replied.[15]

Chemical surveys are viewed negatively by industry as a tool for targeting, promoting, and measuring waste reduction. Often industry is concerned that dissemination of multimedia information about their waste outputs, perhaps in conjunction with information on toxic chemical raw material use, will expose proprietary information about its operations. For example, such information can reveal to competitors a firm's production rate and inferences can be made about details of its process. Especially for smaller companies, there are also concerns about the time, money, and expertise required to accumulate data for what may be enormous numbers of hazardous chemicals. Many industrial operations make a number of products at different times, and in such circumstances putting together complete information poses particular burdens. Another difficulty arises from the level of sensitivity demanded. For example, a company may know how much of a chemical it releases in terms of tons or pounds but not necessarily in terms of lesser amounts. Getting such information, which may or may not be significant environmentally, could be costly. It would be difficult to expect companies to conform to a precisely specified level of sensitivity in measuring use and output of hundreds of chemicals.

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[14] As this report was going to press, Congress had finished its conference committee deliberations on new Superfund legislation. Details of the final bill, however, were not available in time to discuss their relevance here.

[15] Robert Abrams, Attorney General of New York, "Toxic Chemical Accidents in New York State: The Risk of Another Bhopal," January 1986, p. 13.

An inventory approach would only benefit waste reduction in a direct fashion if: 1) it was comprehensive with regard to substances (including those created during the industrial operation) and environmental media, and 2) it asked for data for processes within a plant and put the data on a production output basis. It would be very difficult to enforce and it would take resources to collect, analyze, and report the data for all industrial pollutants nationwide. It might be possible to alleviate administrative problems by starting out with a survey of selected industries.

Information obtained from a standard chemical survey has many potential uses, such as worker protection, emergency response, and pollution control regulations, and because of this there has been considerable interest in the approach. But as with any information that leads to greater awareness of the generation of hazardous waste, it may lead to increased efforts by industry to control pollution and its effects rather than to prevent pollution. A classic example is that instead of cutting levels of toxic chemicals in the workplace—perhaps even below regulatory limits—companies may act on information about toxic levels by giving workers masks and breathing devices or by installing sophisticated alarm systems that warn of unsafe levels of contamination.

Survey data could also be used to enforce compliance with government standards on safe levels of waste outputs and could help establish which chemicals should be targeted for research, standard-setting, and waste reduction.

Mandatory Amounts of Waste Reduction

The government has often set acceptable levels for discharges into the environment. In the same fashion Congress could create a regulatory requirement, either as part of RCRA and the other major environmental statutes or through new legislation, which would mandate specific levels of waste reduction over a specified amount of time. This could be done on an industry or waste basis. Waste generated per unit of production could be set by performance standards for industrial processes or through best practice or best technology requirements. (See ch. 5 for a discussion of how this approach is used in current regulatory programs.) This is the way waste reduction has been regulated in Austria, for example.

This approach would rest on the government's ability to determine the amount of waste reduction possible or what the best industry practice is for an enormous range of industrial activities and an even greater number of waste streams. As will be discussed later, because there are so many ways to reduce waste—from changing feedstocks to changing the end product—this type of effort is more demanding than efforts required under existing environmental programs which set specific limits for what comes out at the end of the pipe. Moreover, any such standards might become outdated; even setting standards could act as a disincentive to greater levels of waste reduction that might be feasible for some generators.

A prescriptive approach to waste reduction appears attractive to some, and EPA was directed by Congress in the 1984 RCRA Amendments to study such an option. (Companies surveyed by OTA say that a mandatory approach would be ineffective in promoting more waste reduction.) It is, however, possible to contend that such a system might indeed result in more waste reduction than does a voluntary program.

If the chief advantage of this approach is that it would step up waste reduction, its chief disadvantages are major and not easily solved problems of design, implementation, and enforcement. Lack of flexibility might harm troubled manufacturing industries. There are so many technical approaches to waste reduction and they are so much a part of the fundamental aspects of production technology that setting levels of required waste reduction would be a formidable task for government. The diversity in American industry has already confounded traditional end-of-pipe regulatory programs, and problems would be compounded many times in a mandatory waste reduction regulatory approach for production activities within plant operations. The information requirements for setting federally mandated waste reduction levels would be so great that it would take years of data collection and analysis before such an effort could begin. In the meantime, there would be considerable uncertainty in industry, which could act as a disincentive to continued voluntary waste reduction. EPA has had major difficulties over many years in establishing comprehensive and reliable databases on waste generation, and for purposes of mandating waste reduction very little of this existing data would be of help.

In order to deal with the problem of acquiring enormous amounts of technical information, proponents of this approach suggest incremental implementation. Administrative problems might be circumvented to some extent by using a prescriptive approach only for some particularly hazardous and widespread wastes initially or for some industries or major industrial processes. Later, with more experience, the prescriptive approach could be applied to either more waste or more industries. However, it is likely that there would be considerable debate over the selection of any waste or industry as the first in a mandatory program. The chemical survey action discussed previously would not necessarily reduce the information burden for establishing required levels of waste reduction, unless the survey obtained process specific data.

One way around many of these difficulties would be for the government to establish waste reduction targets for specific processes or wastes with a provision allowing generators to offer justification for noncompliance based on technical or economic circumstances or to offer a schedule for meeting the target. Instead of devoting substantial resources to developing mandatory waste reduction levels, softer targets could be used. In this way the burden of proof and effort would be shifted to the waste generator, and considering the site-specific nature of waste reduction, this is not unreasonable. However, targets set by the government might also serve as disincentives, discouraging plants from carrying out as much waste reduction as they could. Yet, because zero waste generation is unrealistic for most situations, some finite, defensible target for waste reduction would have to be set by the government. Setting too high a target for reduction would mean that industry and government would be constantly dealing with requests for noncompliance or delay; a target that was too low would mean that waste reduction which could occur might not. If targets—in contrast to goals, which are discussed later—became just a different form of government required waste reduction, these problems would probably constitute nearly as significant a disadvantage as those for specific prescriptive levels set by regulation.

Taxing Waste

An action which has gained a great deal of support in recent years is that of imposing a tax on the generation of hazardous waste. This approach received considerable congressional attention during the debate on the reauthorization of the Superfund program. It has proven to be a very contentious issue. In a previous study, OTA examined waste-end taxes[16] and this subject will not be reviewed here in detail. In looking at such taxes as imposed by over 20 States and at various proposals for Superfund for RCRA defined waste, it is clear that taxes have been set at too low a level to have a significant impact on waste reduction decisions, especially in comparision to waste management costs born by industry. Most taxes on wastes are less than 10 percent of waste management costs. Although OTA has had a more positive view, there has been considerable opposition to the waste-end tax approach for Superfund, on the grounds of administrative problems or a lack of equity (i.e., only some current waste generators who had responsibility for causing Superfund sites are to be taxed). Another objection has been the harm such a tax might cause to some industries facing stiff foreign competition. All these issues and the need to have a relatively high tax rate if it is to affect waste reduction decisions suggest that the taxing approach would face stiff opposition from generators.

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[16] U.S. Congress, Office of Technology Assessment, *Superfund Strategy*, OTA-ITE-252 (Washington, DC: U.S. Government Printing Office, April 1985).

Finally, a way to make a waste-end tax particularly useful for promoting waste reduction (rather than just as a means to raise revenues) is to consider the use of tax rebates or credits associated with specific waste reduction activities. The idea would be to offer an incentive to carry out waste reduction. Major problems would probably arise associated with demands for incentives or rewards retroactively from companies that had already carried out waste reduction. Other disputes would center on inequities that would inevitably arise because of the substantially different capabilities of companies and industries to carry out waste reduction.

Waste Reduction Research and Development

EPA's Office of Research and Development (ORD) could establish a program to assist generators in developing waste reduction technology. Indeed, if a mandatory approach was pursued, ORD would be *expected* to develop the technical information base for establishing regulations. However, ORD has faced continuing problems with regard to budgets. As already noted, the diversity of waste reduction approaches, industries, and waste streams implies a large R&D effort. Existing ORD staff would not have the necessary range of expertise and experience. Unless substantial new funding was provided, concerns would be raised that current pollution control efforts, which many believe to be underfunded and slow, might be harmed. But R&D on waste reduction might not, in fact, turn out to be better funded or carried out more quickly than are current programs. Lastly, many sophisticated or cynical people in industry might have trouble accepting the reliability of information for waste reduction developed by EPA or any government agency with strictly end-of-pipe experience. Government personnel are not likely to have the detailed information and experience required on the vast range of industrial production practices.

To overcome these problems, a formal EPA waste reduction technology program could: 1) fund research by industry, with a focus on topics of a generic nature so that there could be broad application of successful results in other companies and industries (e.g., substitution of other substances or less toxic forms of widely used production inputs such as paints, inks, dyes, and solvents); 2) support university programs that not only research technologies, but also help educate and train people about waste reduction; 3) support technical assistance programs at universities or those run by trade associations; and 4) support technical information clearinghouses in States or regions.

Change Government Procurement Policies

For some companies and industries the Federal Government is a major customer and because of this they have special problems in altering inputs or processes for waste reduction purposes. There are cases in which government specifications, especially in the Department of Defense, rigidly restrict a manufacturer's freedom to change either a process or a product in any way and others where more flexibility is allowed. For example, the government can require cadmium electroplating on a product; but such a process will generate cadmium waste which is hazardous. Sometimes, the plating process is specified. But, in other cases cadmium waste can be eliminated or reduced by either changing the process or by using an alternative metal plating, which might lead to increased costs. If the government were to initiate a major program on waste reduction, many in industry could find it difficult to meet that government goal because of the restrictive nature of these government procurement policies. Moreover, Federal agencies themselves are waste generators and they are now beginning to examine waste reduction. Government agencies would have to make difficult judgments about the acceptability of cost increases associated with achieving waste reduction goals and they would not necessarily see direct benefits. One way to work expeditiously within the current procurement system might be to use waste reduction waivers whereby a company could succinctly present its case for changing some procurement specification on a waste reduction basis. The burden would be on the company to demonstrate that there would be no effect on the performance of the product and also that the benefit would be an environmentally significant level of waste reduction. Because most major government agencies have substantial environmental staffs, it would not be overly difficult to have in-house experts evaluate these waiver requests.

Overall Evaluation

The preceding discussion has covered the advantages and disadvantages of the various proposed actions included under Option II. But what are the advantages and disadvantages of the option as a whole? **If the Federal public policy goal is to achieve rapid and comprehensive hazardous waste reduction, then this option is not likely to be effective for one basic reason. The historic evidence is persuasive that all previous attempts to use our existing, pollution control environmental statutes and programs for waste reduction purposes have not been successful.** Moreover, not only are the prospects for success unlikely, but the potential for negative effects resulting from inflexibility and high costs, especially for troubled manufacturing sectors, are significant. Those who favor this option, however, may propose that a more focused effort to use the current system for facilitating waste reduction might be effective or that some of the specific actions considered might be effective without adopting the others.

Policy Option III: A New Highly Visible Waste Reduction Program

This option emphasizes Federal support for the primacy of waste reduction over treatment or disposal. Implementation of this option would create a new waste reduction ethic as well as a new environmental protection strategy. The program that would result would be based on pollution prevention and would complement the current pollution control system, although few new responsibilities would be added to existing EPA programs. One premise underlying this option is that attempting to use existing environmental statutes and programs is not the optimal approach, as evidenced by the history of attempts to include waste reduction as part of pollution control programs (see ch. 5). Therefore, this option entails substantial institutional change and raises more concern about implementation than does Option II.

Federal *assistance* and provision of direct incentives to spur rather than require more waste reduction would be essential aspects of these new efforts. However, a case can be made that there should be some components of this option that place stringent Federal *requirements* on waste generators. (This does not have to mean that generators are required to reduce wastes by certain amounts.) A further consideration is that public policy relating to U.S. industry must address enormous diversity. Companies are at vastly different stages of waste reduction and face markedly different obstacles to maximizing waste reduction. This option speaks to the need for policy diversity and flexibility. Specifically, six actions are discussed in this option. They are to:

1. establish a grants program,
2. initiate new waste reduction legislation with expanded Federal reporting and planning requirements for industry,
3. establish reporting requirements for financial reports,
4. set up a new Office of Waste Reduction in EPA with an Assistant Administrator,
5. set up regulatory concessions for compliance, and
6. establish and empower State Waste Reduction Boards.

These actions can be implemented singly or in various combinations. Some could be transferred to Option II. The last action in this option requires a brief explanation at this point. The State Waste Reduction Boards suggested by OTA would make the States the primary authorities in implementing a national waste reduction program without necessarily displacing current State efforts or imposing Federal interests on them (see ch. 6). The two chief arguments for promoting State involvement are: 1) the enormous diversity of waste reduction opportunities and problems in industry might best be dealt with by giving government closest to industries the major responsibility; and 2) the need to be sensitive to past and current problems at EPA in implementing its large number of complex programs. The State Waste Reduction Boards, as will be discussed, could be a means of creating a government institution to advocate waste reduction and provide a balance to State pollution control regulatory agencies. Other activities in Option III could, however, be implemented without creating State Waste Reduction Boards.

One other preliminary point needs discussion. This option does not include any form of direct financial assistance to waste generators to implement waste reduction. The main argument against direct assistance is that waste reduction is tied closely to production operations. Therefore, if requests for direct financial assistance were to be considered, it would be difficult to determine how much spending was to be used for waste reduction independent of, for example, modernization of a plant or process. This basic problem has been recognized by some States, including Washington. A report from the State's Department of Ecology says:

> Because waste reduction is so intimate to each manufacturing process, it will be very difficult to determine what portion of the cost of a process change is attributable to waste reduction and what portion is due to a company's need to fulfill a new production need or marketing strategy, or to achieve lower production costs. This uncertainty would make such an incentive program difficult to administer and suggests that its cost-effectiveness would be low.[17]

There is also a problem that results from the fact that there are so many ways to reduce waste. A waste generator could obtain funding, pursue several different approaches to reduce a given waste, and then adopt the one that produced the best results. Moreover, government actions to provide direct financial help typically focus on capital investments, and this skews actions towards equipment purchases even though other measures may be appropriate and available. These factors, coupled with the very large number of potential applicants, would mean that large sums of Federal money would be needed for *any* direct economic assistance program for generators.

For all these reasons, OTA has not considered feasible a number of traditional economic incentives, such as tax credits, deductions, rebates, and exemptions, or direct financing though grants, loans, and loan guarantees. These would not be practical economically or politically at this time. This might change if better information supported such efforts and spending. As has happened in the past with some government financing programs, direct support for waste reduction could mushroom beyond any anticipated levels. If limited sums were made available, the government would have great difficulty in selecting the companies to receive assistance, especially since the government has so little information on waste generation and reduction on which to base assessments of applicants' proposals. **Perhaps at some time in the future a strong case might be made for direct financial assistance to waste generators if it became clear that major waste reduction would not occur without it, but that case cannot be made now.**

A Grants Program

In the past, environmental grants programs have for the most part given money to State or local government agencies. The program suggested here would instead fund nonregulatory efforts to motivate and assist the private sector *broadly* in carrying out waste reduction efforts expeditiously. The purpose of this program would *not* be to provide direct financial support for specific waste reduction efforts beneficial only to a particular waste generator. Instead, its primary goal would be to help build knowledge, institutional support, and the delivery system so that waste generators could more easily and more effectively meet national goals of increasing the pace and scope of waste reduction. The types of efforts funded could be of importance for larger companies, which generate most of the Nation's waste, as well as for smaller companies. It is incorrect to conclude that all large companies have the resources to devote to these efforts or that they would choose to use significant parts of their resources for this purpose. This is particularly true of companies in troubled manufacturing sectors.

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[17] Washington State Department of Ecology, *Progress Report: Priority Waste Management Study for Washington State Hazardous Wastes*, May 1985, pp. 7-12.

There are a number of purposes for which grants could be used:

- Grants could be made to nonprofit organizations to establish free or low cost technical assistance and technical information transfer programs dedicated to industrial waste reduction efforts. Several States do this already and some trade associations and educational institutions could also become involved through such a grants program.
- Grants could be offered to trade associations, business organizations, and educational institutions to develop and make available to workers—from shop floor to researchers to managers—training materials for in-plant use that would bring attention to and encourage waste reduction.
- Grants would be available to any organization for R&D, pilot tests, and demonstration tests if their proposed project aimed to obtain new waste reduction technology or new waste reduction applications of existing technology, yield lower costs, or expand opportunities for waste reduction activities. These results would have to be broadly applicable to industry segments or generic types of processes, wastes, or materials. An example would be substitution of water for organic solvents in widely used industrial processes. Assistance could be provided to a waste generator as long as the project had applicability to significant numbers of other generators and the results of the grant-supported work were to be made public.
- Grants would be available for industry or business organizations and educational institutions to establish programs or materials to train and assist industry personnel in complying with waste reduction reporting and planning requirements and in preparing requests for regulatory concessions as discussed below.
- Grants could be used to create programs to train and certify environmental auditors, who could play a major role in assisting industry to identify and implement waste reduction audits, plans, and programs.

For the reasons given previously, the grants program would *not* offer financial assistance to companies for their direct waste reduction costs (except as noted above for new generic technology development), but it would help improve their tools for such an effort. A limited Federal grants program based on the multiplier effect of broadly applicable efforts might be advantageous. A grants program implements the concept of using a positive, *directly supportive alternative to regulations*. Providing technical support to many companies might offer benefits far in excess of the cost to the government, substantially reducing the Nation's generation of hazardous waste.

The chief disadvantage is the possibility of ineffective spending. The success of such a program will be closely related to the amount of funding provided and what is funded. While it is not possible to know beforehand how effective such a grants program would be, it may be a type of effort worth trying at this early stage of waste reduction implementation. A long-term commitment will be necessary, however, if a grants program is to spur in-depth, dedicated efforts which can be applied broadly to industry. A reasonable compromise between the uncertain effectiveness of such a program and the need to offer funding beyond a 1- or 2-year period could be for Congress to authorize funding for a 5-year program. For example, spending about $50 million (at a minimum) annually for a 5-year grants program would be approximately equal to the cost of cleaning up 25 or fewer sites under the Superfund program (some 3 percent of National Priority List sites). Put another way, American society spends over $70 billion *annually* to regulate, control, and clean up environmental pollution; spending less than *one-tenth of 1 percent* of that sum to aid pollution prevention does not appear extravagant.

Concerns are likely to be raised if the responsibility for selecting projects for funding under such a grants program were given to EPA. The chief reason for this is that EPA does not have the relevant experience for administering such activities. As will be discussed later, State boards could select projects for funding and also act as the agents to receive and distribute Federal funds for encouraging waste reduction activities. Sums could be given by EPA to States on some formula basis. Congress may also wish to consider giving preference to those requests for grants that offer cost-sharing, or even to require cost-sharing. With the likely exception of the technical assistance/technical information function, not all of the above activities would necessarily be carried out in all States. Many activities would yield results that could be transferred to other States.

New Waste Reduction Legislation

Consistent with the definition of waste reduction used in this study, Congress could consider new legislation dedicated solely to waste reduction. Such legislation could address the problems of definition and measurement that have already been discussed. It could establish national waste reduction goals. Through such legislation, industry could be required to: 1) provide detailed information on past waste reduction efforts on a plant, chemical, and process or product basis, including their environmental impacts; and 2) provide detailed plans and schedules for future waste reduction with an emphasis on environmental risk reduction. While these would be regulatory requirements, they are not the same as setting waste reduction standards or requiring a certain level of waste reduction. Nevertheless, this sort of stringent Federal requirement brings up important issues with regard to effectiveness and the likelihood of promoting innovative responses.[18] When it comes to planning and reporting requirements for waste reduction, stringency is provided by setting up a comprehensive, multimedia definition of hazardous waste and by requiring quantitative information (in contrast to current waste minimization RCRA requirements) and specific commitments.

In terms of the congressional legislative process, new legislation might avoid the problem of differing definitions inherent in different environmental statutes considered at different times by a number of congressional committees. New legislation also may be necessary because the following questions are likely to be raised if current environmental statutes and programs are used for a major waste reduction thrust:

- In the context of the air and water programs, does waste reduction apply to wastes for which the government has not established health effects, safe exposure limits, or environmental risks? That is, if the case cannot be made to set regulatory standards for these wastes, can it be made for reducing these wastes?
- Does waste reduction apply below levels set by current regulation as acceptable for discharge into the environment?
- In the context of RCRA, does waste reduction cover unregulated waste?

New legislation could establish the requirements for multimedia waste reduction without undercutting the jurisdiction of existing pollution control statutes and programs.

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[18] An important conclusion from a review of the environmental regulatory programs was that "the stringency of regulation is an important determinant of the degree of technological innovation." [Nicholas A. Ashford, et al., "Using Regulation To Change the Market for Innovation," *Harvard Environmental Law Review*, vol. 9, 1985, pp. 419-466.] Technological innovation is even more important for waste reduction than for pollution control, because for the former there are more side benefits for the entire production system. Innovation for pollution control may lower costs and reduce pollution, but is not likely to have such broad effects.

Reporting and planning requirements would include:

- data on the amounts of specific wastes generated and their disposition—including all wastes, emissions, and discharges of hazardous substances and not just RCRA defined wastes—to delineate which are being rendered permanently harmless through effective treatment and which are being disposed or dispersed;
- quantitative descriptions on a plant and waste (or product or waste generating activity) basis to substantiate past waste reduction;
- periodic detailed plans to reduce all wastes, even those that are being treated, including quantitative estimates for specific wastes over specific intervals; and
- assessments of the environmental effectiveness of waste reduction efforts; these could be prepared by outside, certified professional engineers or firms specializing in environmental auditing.

Congress could establish generic criteria for compliance on reporting. For example, compliance might be recognized only when an industrial operation provided: detailed and quantitative descriptions of waste generation on a production output basis, timely responses to requirements, attention to all of its hazardous waste outputs, attention to multimedia analysis of waste outputs, attention to degree of hazard of the wastes, and analyses of environmental risk reductions already achieved or to be achieved at the site.

A new waste reduction statute could also establish a national waste reduction goal (see ch. 3). A goal of, for example, 10 percent annual waste reduction for 5 years might be helpful in focusing attention on waste reduction and its implementation. It could serve as a guidepost to, albeit approximately, evaluate the progress of all waste reduction efforts, whether at the plant, company, industry, or State level. However, using such a goal might inhibit a higher level of waste reduction. And yet a company might see the establishment of a national goal as an opportunity for it to demonstrate its excellence. Either by statute or by guidance under EPA, acceptable ways of calculating waste reduction could be established (see ch. 4).

The chief advantage of new legislation is that it would establish an environmental protection strategy based on waste reduction parallel to existing strategies for end-of-pipe waste management. Moreover, it would help sharpen the distinction between waste reduction and effective waste treatment on the one hand and disposal and dispersal on the other. It could cover wastes not currently covered by statute or regulations. It would make it much more difficult for a purported waste reduction effort to consist of cross-media transfers. Since a definition should be used that states that waste reduction must involve reduction in environmental risk, it might be necessary to classify wastes according to their degree of hazard. If so, this could be done either in the legislation or by directing EPA to establish such a classification. The availability of such information would provide guidance to industry in establishing priorities. Guidance could also be given about site-specific factors that affect exposures to hazardous substances. It could assist industry in assessing exposure levels and, hence, environmental risks.

A major concern about implemention is deciding how the reports and plans would be handled. It would seem apparent that they should be received by appropriate regulatory agencies, with EPA as the obvious choice, but the history of EPA in establishing national databases and information transfer systems has not been good. Thus, it may be attractive to have State agencies play a major role (see section on State Waste Reduction Boards) or, as will be discussed below, to change the organization of EPA. As only a few States have been more efficient than EPA in establishing databases, a new, dedicated EPA effort might be the most effective action.

Reporting Requirements for Financial Statements

If Congress decides that waste reduction is of paramount importance, a case could be made for requiring public corporations to report on their waste reduction to the Securities and

Exchange Commission (SEC). Such reporting would take place in the standard SEC 10K reports required of corporations and used in drawing up an annual report to shareholders or a prospectus for a new securities offering. This requirement could inspire management to give a great deal of attention to waste reduction efforts and their outcomes. Just as waste reduction can be seen as a criterion to assess production technology and environmental protection programs, it can also contribute to assessing the financial well-being of a company. From the traditional perspective of the SEC, therefore, the issue would be whether information on waste reduction fits into the SEC concept of "material facts" which a reasonable investor would want to know.

OTA finds that a case can be made in this regard. Waste reduction information constitutes material facts of importance to investors because there are several links between waste reduction and the financial condition of a company. The more effective waste reduction measures a company accomplishes, the lower its liabilities for all forms of waste management will be. This includes cleanup liabilities, criminal liabilities, and third-party lawsuits under Superfund and RCRA, liabilities associated with transportation accidents and worker exposures, and costs for regulatory compliance in the future, including possible litigation costs. The following comments by an executive of Du Pont are pertinent:

> The challenge to reduce the amount of waste generated is directed by the society in which we operate and by our stockholders . . . Stockholders benefit through reduced production costs and a reduction of future liabilities. These increase both short and long term profits.[19]

A disadvantage of this approach is that nonpublic corporations would not be directly affected, as they do not have to comply with SEC requirements. On the other hand, knowing that waste reduction information may be required for future actions if the company decides to go public and that such information is being made public by competitors might encourage even nonpublic companies to respond. Further, with such a requirement in force, lending institutions would probably expect nonpublic companies as well as public corporations to provide this information. In any case, it is likely that only a small fraction of the Nation's hazardous waste is generated by nonpublic companies.

There would, of course, be concerns about the length and detail required for any such reporting, but the formal reporting of waste reduction efforts discussed earlier could generate the information for this action. The government would have to establish clear, standard definitions for waste reduction, including what wastes are covered, what constitutes waste reduction, how it is measured, and what information can be kept confidential. New waste reduction legislation, if it was enacted, might require only summary information. One provision might be that any company could simply state that it was not a generator of hazardous waste and, in that case, it would not have to report anything. Another variation would be to exempt from a waste reduction reporting requirement any company that spent less than a certain fraction of its income on waste management.

Either by statute or through SEC rulemaking, companies could be directed to calculate waste reduction by using specified procedures. For example, waste reduction should be assessed on a production output basis, as discussed in chapters 1 and 4. The following facts might be required of a waste generator in its annual SEC report:

- information for the past 5 years on total waste generated in tons, perhaps in terms of some base year's production (analogous to using constant dollars rather than current dollars) or, alternatively, information on annual spending on waste management for the past 5 years;
- information for the past 5 years on total companywide waste reduction, given as a percentage; and
- a narrative description of the company's waste reduction program, including any

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[19] Howard Todd, op. cit.

unusual circumstances that account for its results and its outlook for future waste reduction.

Finally, this approach might be more effective if there was a national goal set for waste reduction. In this way investors could assess the company's performance relative to the national goal.

A New Office of Waste Reduction in EPA

Congress could create an Office of Waste Reduction within EPA, directed by an Assistant Administrator for Waste Reduction. **If waste reduction is as important environmentally as virtually everyone who addresses environmental issues says it is, then arguably its importance should be reflected in the organization of the Nation's EPA.** As discussed previously, under the current organization it is unlikely that waste reduction could be given high priority. If a waste reduction office were placed within a program office, such as the Office of Solid Waste, it would be difficult to establish a multimedia waste reduction effort. Moreover, program offices now appear overburdened with their pollution control efforts.

The implementation of the previous actions might be efficiently handled by an entirely new EPA office if it had sufficient resources and were given high priority by EPA's management. Such an office would be responsible for implementing legislation dealing solely with waste reduction, such as a grants program. It could also play a major role in promoting the development and use of waste reduction technology by collecting and analyzing reports and plans in order to establish an effective national database on waste reduction. It would also be responsible for providing oversight to State efforts funded through EPA.

Finally, concerns that waste reduction efforts might divert attention from current pollution control programs could be allayed if there were a separate waste reduction office in EPA. Also, because current spending on waste reduction is such a small fraction of the EPA's spending—some 0.1 percent—even major increases in the waste reduction area need not affect other programs significantly. On the other hand, there are valid concerns about increasing the organizational complexity and responsibilities of EPA. But, if waste reduction efforts are successful, then ultimately less government intervention will be necessary since there will be fewer generators and waste management facilities and less waste to regulate.

Regulatory Concessions[20]

A regulatory concession would economically reward a company that is committed to accomplishing an environmentally significant amount of waste reduction. It acts as an incentive for compliance with national waste reduction policy goals and regulatory requirements. It works also as a way to introduce a degree of regulatory flexibility into the current system and this could facilitate a smooth transition from pollution control to waste reduction. Essentially, it would be a way to alleviate the economic burdens imposed on waste generators who must simultaneously spend money to comply with existing regulations and make investments for waste reduction. Investments for waste reduction may make less economic sense if investments have already been made for pollution control. This approach becomes more important as a company moves from the simplest to the more costly waste reduction measures (see ch. 3) and has economic obstacles to overcome before net, long-term savings can be realized through avoiding repeated compliance costs and liabilities.

Regulatory concessions to the waste generator could include for example:

- environmental permits valid for longer times or deferred while a waste reduction effort was being implemented on a waste covered by a permit;

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[20] This concept is different from emissions trading or a marketable permit system; in these, a waste generator can buy a credit from someone else and apply it to his own activities and compliance. OTA has not considered this an effective approach for waste reduction, mainly because it is likely to remove the motivation for waste reduction for many generators—either because they might be able to buy someone else's reduction, or because they might not be able to sell a reduction. Moreover, this approach is subtly predicated on the government setting some level of waste reduction, beyond which a company would have something in excess to sell, and the difficulty of setting such levels has already been discussed. Finally, EPA's attempt to use emissions trading under the Clean Air Act has not been especially successful.

- special designations that would enable a plant or company to request priority status in dealings with environmental agencies and programs;
- specific exemptions, variances, or delistings offset by the environmental benefits of the waste reduction in cases in which these concessions can be justified *quantitatively* by the company (analogous to the bubble and emissions trading concepts under the Clean Air Act);
- special consideration for exemption from regulation to firms with RCRA hazardous waste treatment facilities for certain inplant recycling or recovery operations; and
- longer times granted for the storage of hazardous waste without a RCRA permit if need is sufficiently substantiated.

It is important to provide assurances that such concessions depend on a strong case being made that a company's successful waste reduction efforts will result in an *overall net improvement* in environmental protection. Waste reduction should be seen as an alternative to pollution control regulations, one that offers more environmental protection in the long term. Another way to examine this approach is in terms of systematic environmental risk management involving a multimedia view of waste and long-term view of beneficial effects.

The idea of regulatory concessions may sound more novel than it really is. Within current regulatory programs there are areas of discretionary power which are used to assist industry. Most often this occurs when economic hardship is given as the reason why a company cannot be in full and timely compliance with regulations. Here, concessions would not be given because a company has trouble complying with existing regulations. Instead, a company would be rewarded for pursuing a new and effective environmental protection strategy. Therefore, an important indirect benefit of using the regulatory concession approach might be to allow a tightening up of current pollution control regulations. The point is to encourage companies to implement waste reduction goals rather than to avoid or stretch out compliance with existing pollution control regulations.

Offering concessions for waste reduction might appear to remove the current indirect incentive of conforming to costly pollution control regulations. But this presupposes that a specific waste generator who is faced with current or anticipated costs of pollution control regulatory compliance can also fund waste reduction efforts. Thus, **it is important to recognize that regulatory concessions would not remove the current indirect regulatory economic incentive for waste reduction, but rather provide assistance in making a prudent response**. The fundamental problem with relying on an indirect incentive is that, as discussed previously, there is no assurance that it will call forth the desired response from most waste generators. The approach of offering concessions is used in Japan to achieve flexibility and economic efficiency in regulatory programs; some of the rewards derive from its regulatory program's requirements and are determined by a local agency.[21]

In principle this approach has already been used by Congress (see ch. 5). For example, the Clean Water Act was changed in 1977 to allow a generator to obtain an extension on a compliance date by:

> . . . replacing existing production capacity with an innovative production process which will result in an effluent reduction significantly greater than that required by the limi-

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[21] The concept of using regulatory concessions falls into the broad area of adapting and improving the U.S. approach to environmental protection. A recent study has noted:

> . . . U.S. firms have spent more in pursuit of environmental goals than have firms in other nations, and . . . environmental regulation has had a slightly more negative effect on the U.S. economy than on the other three nations [Canada, Japan, West Germany] . . . [A]lthough U.S. standards are generally less stringent than those of Japan, environmental regulation appears to have had a more dramatic impact on the U.S. economy than in Japan. Thus, the standards set by the regulatory process might be less important than the manner in which they are carried out. [U.S. Congress, Congressional Budget Office, *Environmental Regulation and Economic Efficiency*, March 1985.]

It should be noted that the study was based on analysis of data through 1982. The increasing attention being given by environmental programs to toxic chemicals, therefore, was not yet fully reflected. Regulatory reform to mitigate harmful impacts of regulations on U.S. industry may have increasing importance.

> tation otherwise applicable to such facility and moves toward the national goal of eliminating the discharge of all pollutants . . . [22]

This waste reduction opportunity has not been used very much, perhaps partly because the statute provided the same opportunity for use of innovative pollution control technology. Pollution control has been the standard choice in industry.

The concept of regulatory concessions as used here does not necessarily call for innovative technology but rather includes all measures that reduce waste, even if they are not innovative in the usual sense of the word. This is important because placing a requirement for innovative technology has probably been another reason why regulatory innovation waivers (also in the Clean Air Act) have not been particularly successful, even for pollution control.[23] Concessions for waste reduction would place no burden on the generator to demonstrate anything but: 1) a good-faith effort to reduce waste by any means chosen by the generator; 2) that, most importantly, there will be a net, overall environmental benefit; and 3) that within an agreed-upon time the project has succeeded in its objective. Emphasis would be on the fact that the government is prepared to forego short-term, often uncertain benefits for significant, long-term, permanent reductions in environmental and health risks.

Another example of the use of regulatory concessions is in the area of worker health and safety. In 1982 OSHA created three programs that recognize the achievements of companies that are leaders in providing health and safety benefits to their employees and that provide additional opportunities for OSHA/employer consultation and cooperation. Recognition is given for superior performance by a company. Participating companies, which so far are few, are exempted from OSHA programmed inspections and are promised expedited action on variance applications. The OSHA programs are explicit attempts to promote a more cooperative approach between government and industrial firms and to enhance worker health and safety. But this approach has had its critics, who are concerned about regulatory concessions and the diversion of government resources away from routine regulatory activities.

EPA has expressed concern about the lack of flexibility in RCRA. The RCRA program has recognized its limitations in dealing with specific site conditions: "Despite the complexity, the RCRA program allows little flexibility for the important characteristics of a particular facility." While it is correct that there is always some discretionary power for EPA to exercise within its regulatory programs, these are not now effective:

> What flexibility exists through waivers and exemptions is often cumbersome and time-consuming to obtain. Furthermore, because EPA and those regulated believe that waivers or exemptions will rarely, if ever, be granted, they do not use them.[24]

There are two scientific principles that form the basis for believing that regulatory concessions for waste reduction can make environmental sense. First, wastes vary remarkably in their degree of hazard. Health effects can vary substantially. They can be acute or chronic; they can be temporary, or they can be long term. For some of these effects no curative measures are available, but others are easily treated. Second, threats to health and the environment from the generation of any waste depend on site-specific conditions that determine the transport and fate of the waste in the environment and consequently the extent of exposure to the waste. Both of these factors form the basis for risk management and risk assessment and have posed great difficulties for the existing environmental regulatory programs. To a large extent, they have been side-stepped and current programs do not significantly account for these considerations (although lately EPA has been considering reforms and programs that would address these risk-related factors). Therefore, **because current pollution control regulations do not effectively account for degree of hazard of the waste and site-specific risk conditions, regulatory concessions for waste reduction do not necessarily sacrifice environmental protection**. If waste reduction focuses on the most hazardous wastes and regulatory concessions on the least hazardous ones, then a net environmental benefit results.

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[22] Federal Water Pollution Control Act, Section 301(k).

[23] Nicholas A. Ashford, et al., op. cit. This analysis of the failures of the innovation waiver efforts concluded that:

> Assigning exclusive authority over the administration of innovation waivers to an office in a position to accord higher priority and greater attention to the program would promote use of the waivers and prevent misuse . . . a specially designated group, trained to interact with industry . . . should administer the program.

Use of boards, as will discussed later, is consistent with this conclusion.

[24] U.S. Environmental Protection Agency, "Hazardous Waste Implementation Strategy," op. cit.

Examples of Concessions.—Examining hypothetical regulatory concessions for waste reduction may be instructive.

Example 1.—A chemical plant generates a large quantity of toxic air emissions which will soon become regulated (by the State and then EPA). It could proceed with investing in a pollution control system to reduce the air emissions to expected legal limits, which would create a fairly large amount of sludge for land disposal. Alternatively, it could pursue a change in its process technology which would eliminate almost all of the toxic air emissions but would take 2 years longer than the pollution control approach. The company would rather make the process change because of other benefits but only if it can get the regulatory agency's agreement that it will not have to meet the air emission requirements over the period during which it is implementing the process technology change.

Example 2.—Reduction can be accomplished for a very hazardous waste which, because it is being discharged in large amounts into the air, also poses risk to a nearby population center downwind from the plant. The company's large chemical manufacturing plant also spends considerable sums on a water treatment plant that will soon require capital spending for major renovation. It must reduce levels of certain low-hazard pollutants in order to meet regulatory requirements before the water is discharged into a waterway where dilution would be substantial and where there is no downstream use for drinking water. From the company's perspective, there is a net economic gain if its reduction to virtually zero output of the currently unregulated toxic air emission can be offset by saving the greater costs of operating and renovating the water treatment plant. Eliminating the air pollution can be more significant environmentally than allowing more waste to go into the river. The company could go through a costly, lengthy process to get a permanent waiver from the requirement to treat the water, but it would prefer a quicker decision hinging on the environmental benefits of the proposed waste reduction.

Example 3.—A small electroplating shop can see a way to greatly reduce its generation of a high-hazard liquid waste which is put into the sewer, but it requires capital spending to change its process to accommodate a new raw material. It could save enough money to offset the new spending within about a year—if it were allowed to accumulate the RCRA waste sludge from its water treatment for more than 90 days without a permit. The company would save money because it would not have to pay a high premium to a waste management firm to collect small amounts of waste. The environmental benefits gained by eliminating the waste that now goes into the sewer are greater than the benefits lost by allowing a longer period for storage of drummed waste.

Example 4.—A medium-sized chemical specialties manufacturer has had a long history of noncompliance and violations. Despite penalties the situation does not improve. The company knows how to stretch out enforcement and seems to accept financial penalties as part of doing business. It rarely seems to take actions which would permanently solve problems such as frequent excessive discharges of pollutants into a nearby waterway. The company knows how to exert its influence as a major local employer. It has learned that regulatory noncompliance is not likely to bring a fatal blow to its operation. As a result of the new waste reduction reporting and planning requirements, the company is able to pinpoint several changes in its production process that could greatly reduce its aqueous hazardous waste stream. It says it is willing to commit a significant amount of capital to make the changes (much more than it was paying in penalties), but only if a number of outstanding enforcement actions are dropped. It argues that its violations are chiefly a consequence of the poor design and condition of the treatment plant and that there are no immediate, substantial environmental effects. It says it will give a detailed plan, certified by an outside expert, of its proposed waste reduction program. This example illustrates the difficulty in assessing a trade-off when the long-term environmental benefits are the central concern.

Costs and Benefits.—In assessing the merits of granting regulatory concessions and acknowledging that they do not necessarily imply a loss of environmental protection, it is critical to deal with the regulatory system as it now exists and not to regard it as an ideal, theoretical program. The current situation has a number of deficiencies:

- Environmental regulations are not complied with at a high rate and penalties for noncompliance may not be effective deterrents.
- Much compliance is self-certified and inaccurate, rather than being based on government monitoring of environmental performance.
- Regulations are not necessarily related to environmental benefits because of loopholes and technical inadequacies or because of a lack of health-based standards or inapplicable exposure and risk conditions for a specific site.
- Different regulatory programs provide different levels of environmental protection in terms of risk reduction or exposure to specific chemicals.
- Many pollution control efforts have, to a large degree, become dependent on the limits of available pollution control technology. There are relatively few incentives to push technological development to achieve greater environmental benefits.
- Many aspects of regulatory requirements are procedural and serve bureaucratic or administrative needs, rather than serving to increase environmental protection.
- Over time there have been many compromises in the structure of regulations in which environmental benefits have been sacrificed to avoid undesirable economic impacts on industry.

No matter how a benefits program is designed, some companies or plants will not be able to justify new waste reduction efforts economically. For example, total costs of regulatory compliance may be too low relative to corporate profits for concessions to offset investments in waste reduction. Only a small additional amount of waste reduction may be possible using regulatory concessions over that without them. But as control regulations drive up waste management costs and as waste *reduction* costs increase and more capital-intensive efforts are required (see ch. 3), regulatory concessions may become increasingly attractive. The somewhat negative experience with innovation waivers, mentioned earlier, suggest ways to make concessions for waste reduction more successful. For example, such a program would have to be well publicized, be open to new and long-standing waste generators, have clear guidance from the responsible government agency, be free of delays, and have a fail-soft approach in case the waste reduction attempt fails. This means that the regulatory agency granting the concession ". . . should adopt a sensible enforcement posture that does not unduly penalize the firm. To prevent possible abuse, however, the agency should strictly monitor progress . . ."[25]

A disadvantage of regulatory concessions is that there will be some opposition to changing a familiar system of control regulations that has developed over several decades. For example, industry has developed adaptive skills and strategies for acting within its legal opportunities to reduce what it perceives to be unnecessary, ineffective, or overly costly environmental regulations. This is consistent with the American adversarial and balancing-of-opposing-forces approaches to conflict resolution. There will be opposition to a waste prevention approach that shifts the focus to the internal operations

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[25] Ashford, et al., op. cit.

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of industrial activities, even though it might offer greater environmental benefits—without imposing economic burdens. Similarly, organized environmental groups have also developed capabilities for representing their interests within the current pollution control framework. They too are bound to have some anxiety about a loss of effectiveness if prevention is also used as a means to achieve environmental protection. These reservations are also likely to be felt in government regulatory agencies.

State Waste Reduction Boards

One way to implement a Federal waste reduction program, if one is deemed necessary, might be through the voluntary establishment of State Waste Reduction Boards. Boards could provide a means for public participation, disburse Federal grant monies to support waste reduction, review generator reports and plans, and make recommendations on requests for regulatory concessions for complying with Federal waste reduction reporting and planning requirements.

Why create another government organization? The best reason is to demonstrate institutional commitment to waste reduction. Citizen boards have been created for pollution control and the siting of waste management facilities in a number of States, but none have yet been set up for waste reduction. A second reason is that OTA's industry survey found some preference for having the States play the major role in such a program. The preference was particularly common among smaller companies. This approach might be appealing to the general public and to environmentalists *if* they were assured that they could be sufficiently involved.

Boards or similarly structured commissions are more widely used at the State than at the Federal level. Waste reduction boards at the State implementation level might be effective in assuring that the Federal waste reduction effort, now directed by a part of the existing EPA system, does not become submerged within or overpowered by concurrent pollution control activities. If boards were established at the State level on a national basis, the public could become more intensively involved in establishing a waste reduction ethic.

One purpose of suggested activities such as establishing State boards is to give greater identity and visibility to waste reduction and to separate it from the dominant pollution control culture. An alternative way of doing this is to create a separate entity within an existing institution, as in the previously discussed action of creating an Office of Waste Reduction within EPA. While this could also be done within existing State agencies, there is some risk that the prevailing emphasis on pollution control might make such an approach ineffective.

Autonomous boards could be open advocates of waste reduction and could:

- bring visibility and independent institutional support to waste reduction;
- promote implementation by those closest to plant operations and minimize Federal bureaucratic involvement and expense;
- promote a direct incentive, nonregulatory approach and move away from a traditional prescriptive approach enforced by penalties; and
- turn towards consensus building among affected parties and away from resolving disputes through confrontation and litigation.[28]

The establishment of boards would not necessarily bring about conflict with present State regulatory or waste reduction efforts, although opposition from existing regulatory agencies could arise. (See the discussion below on how boards might function relative to regulatory agencies.) Would all or most States choose to have such boards? Not necessarily, but considering the number of States that have, for example, established siting boards, waste-end taxes, and waste reduction programs, those States in which the largest amounts of hazardous waste are generated might choose to give such political and visible support to waste reduction. Much would depend, however, on the level of commitment of State legislative bodies and governors' offices. If a Federal grants program previously discussed were to be given to such boards for implementation, there would be a clear incentive for their establishment.

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[28] For example, the previously cited analysis of innovation waivers addressed the problem of deciding exactly what regulatory benefit to grant: "One solution would be a flexible delay period [for noncompliance] to be determined through negotiation between an innovating firm and an EPA technical review panel." [Ashford, et al., op. cit.] The idea here is that the board could serve the same type of function.

Particularly because of concerns that regulatory concessions might be undesirable environmentally, such boards would need to maintain a high degree of independence and credibility based on broad representation. Board members should include representatives from State environmental regulatory agencies, industry, trade and business associations, environmental groups, community associations, labor groups, educational institutions, local government officials, and the general public. It might be beneficial if a certain percentage of the board were people with technical backgrounds in order to assure credibility. There are some State entities, generally siting or hazard waste management boards, which sometimes include waste reduction as one of their concerns, that have such mixed representation and have been quite successful in balancing diverse viewpoints. In these boards primacy is not usually given to waste reduction. The lack of reliable information about waste reduction means that priority is given to waste management.

In order to ensure consistency nationwide, Congress might consider having EPA Regional Administrators serve as members of boards within their jurisdictions. But considering the site-specific character of waste reduction, national consistency is less of an issue than it is with, for example, the implementation of a pollution control regulation. If it is deemed essential to maintain consistency nationwide, however, Congress could specify key features of the boards' structure.

Federal funding for operation of the boards and for grants they might administer could be apportioned on some formula basis as part of a budget authorization to EPA; such a formula basis has been used in grants programs to States under existing environmental programs.

As indicated above, the boards could do more than administer and disburse Federal grant funds; they could complement the decisions of existing environmental regulatory agencies about regulatory concessions. It is this suggested role of boards that is bound to be of concern. The interactions of the boards and regulatory agencies are summarized in table 2-1. The key functions of the boards could be: 1) to evaluate the environmental benefits of an industry's waste reduction efforts in relation to a similar evaluation by regulatory agencies of the environmental costs of requested regulatory concessions, and 2) to make a public recommendation to the regulatory agency on whether to grant the concession. Boards, therefore, could serve to analyze, mediate, and resolve conflicts between industry and regulatory agencies (which may be State or EPA). As is the case with regulatory agencies, these boards would be meant to safeguard environmental protection, but the boards would be the advocates of waste reduction while the regulatory agencies are primarily advocates of pollution control.

It is clear that there are significant implementation issues to be addressed. For instance, it is likely that a grants program could be implemented and industry's reporting efforts started *before* mechanisms were put in place for making the difficult decisions about regulatory concessions. A valid concern about concessions would be how to find the technical resources to evaluate proposals from industry properly and expeditiously. One action that would help avoid creating a large bureaucracy might be to have professional and perhaps certified engineers and consultants prepare key parts of both industrial plans for waste reduction and proposals for regulatory concessions, including the assessment of environmental benefits. Indeed, because of the recent upsurge in environmental audits for compliance purposes, there is a growing interest in using certified environmental auditors as certified public accountants have been used for financial records. The use of specialized third parties hired because of their qualifications in a particular area can be an effective substitute for increasing government staffs.

Table 2-1.—Interaction of Regulatory Agency and State Board: Regulatory Concessions

Government regulatory agency		State Waste Reduction Board
1. Receives waste generator's required reports and plans.		1. Same.
2. Receives requests from industry for regulatory concessions including fully detailed support documentation.		2. Same.
3. Makes initial determination that regulatory concession is within legal powers of the agency to grant, and if positive, proceeds.		3. (Board has no complementary role at this step.)
4. Prepares report on any loss in environmental protection for concession. Goes to Board.	→	4. Receives regulatory agency's report on environmental impact of concession.
5. Receives report on environmental benefits of waste reduction prepared by Board.	←	5. Prepares report on environmental benefits of waste reduction. Goes to regulatory agency.
6. Receives recommendations from Board on granting or denial of regulatory concession.	←	6. Makes recommendation on concession to regulatory agency.
7. Issues decision on regulatory concession.		

SOURCE: Office of Technology Assessment, 1986.

Overall Evaluation

As noted in the discussion of Option II, after the pros and cons of various specific actions have been discussed, the probable result of the overall strategy merits attention. **If the Federal public policy goal is rapid and comprehensive hazardous waste reduction, then Option III is likely to be the most effective.** The chief reasons for this statement are: 1) that the limitations to rapid and comprehensive waste reduction are not fundamentally technical or economic, and 2) that waste reduction is not something industry finds intrinsically unsound. To a large extent, achieving this goal means getting out of a rut; shaking our historic belief that environmental protection is best achieved through end-of-pipe, pollution control techniques. OTA finds that rapid and comprehensive waste reduction may be attainable with a minimum of prescriptive requirements and a maximum of government leadership that focuses on education, assistance, and persuasion and on unswervingly granting institutional priority and backing to the effort. This option also implicitly acknowledges the significant influence of other public and private efforts (e.g., State and local programs, insurance and financial companies, and environmental groups). These other efforts do not, however, diminish the need for Federal leadership. They do suggest that a middle course between the current voluntary approach and a traditional regulatory one is likely to be the most efficient and effective at this time. The reasons in the discussion of Policy Option I for not pursuing a major Federal initiative also support the middle course. If the private sector efforts in combination with Option III did not prove effective, then a more traditional regulatory approach would be justified and could be pursued.

COMPARATIVE ANALYSIS OF POLICY OPTIONS

The three policy options can be put into perspective in two ways. First, criteria can be set up to evaluate them. Second, we can ask who finds each option attractive and why.

The following are useful criteria:

1. **Environmental Benefit**: The relative potential of each option to reach a higher level of

environmental protection (than currently achieved) by hastening widespread, comprehensive, multimedia waste reduction.

2. **Costs**: The relative difficulties that each option would face because of constraints on Federal spending and on raising revenues through new forms of taxes or fees. Costs of implementation for industry and government must also be considered.
3. **Ease of Implementation**: The relative administrative and enforcement problems and delays, and uncertainties about effectiveness. These difficulties result from adding new tasks to existing, already burdened environmental regulatory programs or from creating new programs and institutions.
4. **Adverse Impact on Industry**: The relative potential of each option to directly or indirectly harm U.S. industries, particularly older, mature, and troubled ones.

While the first criterion is positive in nature, the other three deal with the negative attributes of the three options. Although more detailed criteria are possible, these four capture most of the concerns and issues surrounding the choices facing Congress. Nevertheless, it is possible for OTA to offer only rough, qualitative—and inescapably somewhat subjective—evaluations for each of the three options. It is OTA's belief that no reliable data exist to perform quantitative analyses of the costs, benefits, and impacts of various policy options for waste reduction. Because a number of actions within options can be eliminated or transferred among options, it is even more difficult to make a quantitative evaluation.

A summary evaluation using the four criteria is given in table 2-2. As shown in the table, Option I gets the best overall rating and Option III the next best. They differ in all four criteria.

The chief strength of Option I is the low probability of adverse effects, because no new actions are taken. Its chief flaw is the low probability of significant environmental benefits because it does not address weaknesses in the current approach, such as a lack of multimedia coverage. When *only* environmental benefit is considered, this option gets the *lowest* rating.

The chief strength of Option III is that it offers a combination of only moderately adverse effects with the highest rating for environmental benefit. This highest rating derives mostly from the positive effects the grants program, new multimedia legislation (to which waste generators would have to conform in their required plans), and a new Office of Waste Reduction in EPA. The more speculative benefits of other actions, such as regulatory concessions and State boards, were not taken into consideration. The chief weakness of this option is that it requires implementation of new initiatives.

The chief weaknesses of Option II are:

- its potential for causing negative impacts on some U.S. industries, because of the difficulties in using current environmental regulatory programs for comprehensive waste reduction;
- the difficulties of setting a mandatory level for waste reduction;
- the likelihood of high costs for implementation of a chemical survey, and perhaps for enforcing a tax on wastes; and
- its moderate potential for achieving environmental benefits, chiefly because of the

Table 2-2.—Comparative Evaluation of Policy Options

	Policy options[a]		
	I No action	II Improve existing programs	III New strategy
Environmental benefit	Low	Moderate	High
Costs	None	Moderate	Moderate
Ease of implementation	High	Low	Low
Adverse impact on industry	Low	High	Moderate

[a] See text for descriptions of options and specific actions included.

SOURCE: Office of Technology Assessment, 1986.

uncertainty of success in accomplishing multimedia waste reduction within the current environmental programs.

Finally, a general perspective is given for each of the three options. The questions asked are: 1) what is attractive about the option, and 2) what constituency would value that feature?

Option I: Maintain Current Program

This option is most attractive to those who want: 1) to maintain the voluntary approach to waste reduction unless it is clearly documented to be ineffective; and 2) to keep new actions on waste reduction by Congress and EPA to a minimum, until they can be better supported by reliable information indicating that the progress of waste reduction is slow because of current legislation and regulations. This option is likely to be favored by some companies.

Option II: Improve Regulatory Programs

This option is most attractive to those who want government to move faster with waste reduction than is possible under the voluntary approach, perhaps by mandating levels of reduction while maintaining existing regulatory programs. This option is likely to be favored by some environmental interests and some State officials.

Option III: New Strategy

This option is most attractive to those who want strong Federal Government support for waste reduction but to have it implemented as much as possible at the State level. They want waste reduction to have very high priority, visible government commitment, and independent statutory standing as part of developing a new strategy for environmental protection. This option has no clear constituency because this approach has not yet been considered or openly debated. It is likely to appeal to those who find the current voluntary approach unacceptable but who have concerns about traditional prescriptive approaches and about EPA's ability to tackle waste reduction along with its existing responsibilities and under its current mandates.

Chapter 3

Technology and Waste Reduction Decisions

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Chapter 3

Technology and Waste Reduction Decisions

INTRODUCTION

The goals of this chapter are to discuss factors affecting the use of technology for waste reduction and to examine the scope, diversity, and applicability of waste reduction practices.

No attempt is made to give a comprehensive description of proven or potentially effective waste reduction methods for different industries, processes, or wastes. Not only are there many thousands of industrial processes and wastes, but there are also important plant-specific constraints of both a technical and economic nature to waste reduction. Examples of successful waste reduction methods, are instructive, but technologies that are effective in one case may not be applicable for reduction of other hazardous wastes.

It is important to see waste reduction as part of the broader picture of industrial product and process improvement, modernization, innovation, and expansion, not simply as a means to environmental protection. Waste reduction is more accurately thought of as being related to, dependent on, and a contributing cause of all those steps that a company takes to remain competitive and profitable. **It is just as sensible to ask whether, and to what degree a company reduces hazardous waste as it is to ask how much R&D, energy conservation, or productivity improvement the company carries out, what its accomplishments have been, and how these factors affect competitiveness and profitability**.

The phrase *waste reduction technology* in itself can be misleading; the phrase deals more with a goal of technology than with its technical content. Some actions taken toward this goal may be related solely to waste reduction, but most will be intimately related to production technologies, activities, or materials which have some capability for reducing waste without that being their primary function—that of making a profitable product that satisfies customer requirements. Waste reduction methods, therefore, encompass a vast array of techniques and actions that are useful and beneficial in ways that frequently go beyond waste reduction. **Waste reduction can be thought of as a criterion to assess almost any industrial production technology rather than as a unique technology, a machine, or even a field of expertise**.

Two major implications arise from this conclusion. First, the selection of waste reduction technology requires a great deal of knowledge about the specific waste generating situation. This expertise has little to do with pollution control technology but everything to do with production processes, plant operations, and end products. The worker on the plant floor, the manager of the plant, the design engineer, the laboratory researcher, the purchasing agent, and everybody else who has a hand in production can see or explore opportunities to reduce waste—*if* they have been made aware of the need to do so. Waste reduction techniques run the spectrum from simple changes in day-to-day operations to wholesale redesign of process technology or end product. Therefore, even though waste reduction is generally seen solely as an environmental protection activity, it is not. **Waste reduction serves environmental protection goals, but it is fundamentally an improvement in production with beneficial effects that may be widespread.**

People outside of industry who are interested in waste reduction and have experience in the environmental area may take a narrow view of waste reduction; frequently they neither have familiarity with front-end industrial production technologies and techniques, nor with their limitations and opportunities. Conversely, production people may not have paid much attention to the environmental developments that have motivated the call for waste reduction. Therefore, **making waste reduction a goal, motivating and rewarding behavior that reduces waste, and**

setting up an organizational structure that encourages thorough examination of waste reduction opportunities are just as important as selecting or designing waste reduction hardware.

Second, whenever something is done for the purpose of waste reduction, there are likely to be other consequences; these may be just as significant, if not more so, than waste reduction itself. For example, worker productivity may increase as a result of one waste reduction action; product quality might decrease as a result of another action. For each plant, there are costs, benefits, and site-specific constraints to waste reduction which cannot be completely predicted from experiences at other plants. **The feasibility of waste reduction is embedded in the entire production system in which it must take place.**

What all this means is that waste reduction activities are very open-ended and very difficult to describe or assess comprehensively. A further implication is that certain activities (discussed in detail elsewhere) often related to technology use and assessment are not easily undertaken for waste reduction. These include: 1) forecasting, even approximately, how much waste reduction is technically feasible for the Nation, industries, or a specific operation; and 2) suggesting how the government might require companies to achieve a given level of waste reduction.

On the other hand, when the production context and purpose of waste reduction are understood, it becomes clear that there are numerous opportunities to reduce waste. How much waste reduction is achievable depends both on how much *attention* is given to it and on the amount of waste reduction technology that exists. Human factors, organizational structure of companies and government policies all have critical roles in waste reduction decisions. **Success in reducing waste begins with human perceptions of need and requires an examination of a myriad of opportunities.**

THE SPECTRUM OF APPROACHES

Five Broad Approaches to Waste Reduction

Developing a scheme to group the technical approachs to waste reduction is important because the range is so great. There are several ways to do this. OTA has chosen a scheme that emphasizes *opportunities and approaches* for waste reduction rather than types of industries or wastes. Five broad approaches that are applicable to almost all industrial operations have been used.[1] The following list gives these approaches in order of decreasing importance to the respondents to OTA's industry survey (see app. A).

Approach 1: In-Process Recycling

Potential wastes, or their components, can be returned for reuse *within existing operations* (see box 3-A). This approach is more applicable to liquid waste streams than to solids, sludges, or gases. Recycling as a means of waste reduction is an integral part of the production process.[2] For example, at a Du Pont plant making Freon, hydrochloric acid waste was eliminated by installing a $16 million conversion unit to change anhydrous hydrogen chloride into chlorine, which is recycled back into the process, and hydrogen, which is used as a fuel in the plant.[3] Carrier Air Conditioning Co. collects

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[1] For example, the five approaches can be applied to farming and mining. Pesticide runoff can be reduced by using a biological rather than a chemical method of pest control. Changing mining operations can prevent leachate from polluting nearby surface water.

[2] This should not be interpreted too narrowly. In some cases, such as a plant that produces a chemical, recycling a waste or its component is physically a part of the operation; that is, pipes can move waste from one end of the plant to a point near the front end in a closed-loop system. However, in other cases such as paint stripping or vehicle maintenance, recycling of a solvent or motor oil may take place within the same building, at a separate recycling unit, with the recycled material moved periodically for use elsewhere within the building, just as a purchased new raw material would be.

[3] The examples cited in this chapter come from a number of recent reports, conference proceedings, and books referenced elsewhere in this report.

Box 3-A.—Waste Reduction by In-Process Recycling: Countercurrent Rinsing and Recycling of Caustic Soda From Thread Mercerization

In the late 1970s, a French textile company found that it could reduce the amount of caustic soda discharged in wastewater by altering its rinsing process following mercerization to permit recycling of the soda. (In mercerization, thread is immersed in a caustic soda bath containing a wetting agent.) The company's original technology followed mercerization by rinsing the thread in three water baths that were discharged after use. The waste reducing technology replaces these baths with a stream of running water. Soda gradually concentrates in the rinse water until it is efficient and cost-effective to employ an evaporator that will elevate the soda concentration sufficiently to allow the soda to be recycled back into the mercerizing process, along with the wetting agent it contains.

The new technology reduces both the volume and the amount of hazardous waste generated, per unit product. In the old method, 360 kilograms (kg) of soda in 80 cubic meters (m^3) of wastewater were created as waste for each ton of thread mercerized. With the new technique, only 100 kg of soda in 13 m^3 of water are generated. The new process required investments of 1,430,000 French francs, 330,000 francs more than the old process, but is cheaper to operate: 1,320 francs/ton of thread mercerized using the new process versus 2,000 francs/ton using the old process. The waste reducing process requires less energy (15.7 gigajoules (GJ)/ton of thread vs. 19.5 GJ/ton under the old method) and less raw materials (only 170 kg of pure soda and 3.5 kg of wetting agent are required per ton of thread as opposed to 430 kg soda and 8.5 kg wetting agent required for the old process.) It also requires fewer man-hours to operate.

SOURCE: United Nations, Economic Commission for Europe, *Compendium on Low- and Non-Waste Technology* (Geneva, Switzerland: 1981), monograph #26.

and recycles the overspray in its painting operations. Diversified Printing Corp. and Donnelley Printing Co. recover and use 86 and 87 percent respectively of the organic solvents in inks.

Major limitations to in-process recycling include:

- possible significant differences between recycled and virgin materials and the inability to use waste that may be chemically different than the raw materials,
- highly fluctuating market prices for virgin raw materials,
- the greater applicability to continuous vs. batch processes,
- amounts that are too small to justify investment for new equipment, and
- the need in some cases to perform costly steps to separate components before some of the waste can be recycled.

Although in many cases in-process recycling does not require substantial testing and development or capital investment, in other cases it does. This waste reduction option is most closely related to pollution control, which in part explains its wide use (see below).

Approach 2: Process Technology and Equipment

Significant changes in the basic technology and equipment of production, including modernization, modification, or better control of process equipment may result in reduction of waste (see box 3-B). Such reduction may also come about through major changes in technology (e.g., adopting a different way of making a commodity chemical or refining a metal-bearing ore may reduce a company's waste). For example, 3M replaced a chemical process to clean flexible metal electronic circuits with a strictly mechanical process. Professor Raymond Young of the University of Wisconsin (Madison) has invented a new pulp-making process that does not use sulfites and has no sources of air or water pollution; it is in the pilot-testing stage. Lancy International designed a new process for Elkhart Products Inc. to remove oxide and passivate (render the surfaces chemically inactive) pipe fittings by using nonhazardous solutions instead of a cyanide dip and a chromic acid dip. Amoco Chemicals Corp. modified a manufacturing process and reduced its ignitable and oily wastes by 60 to 70 percent.

Box 3-B.—Waste Reduction Through Process Technology and Equipment Changes: Plastic Media Paint Stripping

Hill Air Force Base in Ogden, Utah, has developed an alternative technology for stripping paint from aircraft and ground support equipment. Paint is conventionally stripped from aircraft and ground support equipment with a solvent, typically an acidic methylene chloride solution, followed by scraping, washing (contaminating thousands of gallons of water), hand sanding, and buffing. Chemical stripping is expensive and time-consuming, releases noxious fumes into the workplace, and generates large amounts of hazardous waste. The alternative removes paint with modified conventional sandblasting equipment using recoverable plastic beads in lieu of sand. Waste from this process is only pulverized paint; the beads mixed with the paint dust are easily recovered for reuse in the process.

The plastic media technology has some limitations. It does not strip rain erosion coating, can damage soft cadmium coating and windows, and care must be exercised in stripping carbon composite, fiberglass, and lightweight aluminum surfaces. However, these were considered minor limitations by Hill AFB.

Mechanical stripping technology may be transferred to a wide variety of operations that currently clean and remove paint from metal objects with solvents.

Summary of resulting changes (for stripping one F-4 aircraft):

	Chemical stripping	*Plastic media*
Waste generation:		
Hazardous solid	9,767 lb sludge	320 lb dry waste
Wastewater	200,000 gal	0
Waste management costs:		
Hazardous solid (all trucked to California, cost $200/ton)	$ 967	$ 32
Wastewater treatment	$1,485	0
Investment	Unknown	$647,389[a]
Manhours required	341	39
Raw materials cost	$5,422	$ 346
Energy costs	$ 231	$ 127

[a] For stripping hanger: payback is just over 1 month based on operation cost savings.

SOURCE: DOD Environmental Leadership Project, *Industrial Processes to Reduce Generation of Hazardous Waste at DOD Facilities*, Phase 2 Report: Evaluation of 18 Case Studies, prepared by CH2MHill (T.E. Higgins), July 1985, pp. 3-29 to 3-48.

Major changes often require substantial technological development and perhaps capital investment. It may be easier to make them when redesigning an entire process or designing a new plant or operation rather than as a modification to a part of an operating system.

However, equipment and technology changes do not necessarily require a major process overhaul. Dow Chemical reduced both waste and costs in a crude-product drying system when it installed a computer and on-stream analyzer to adjust the concentration drying agent in the flow. Previously, sampling and lab analysis of the flow was done six times daily and a drying agent was added by hand. The new automated system is able to keep the ratio of drying agent more nearly optimal and therefore reduced the amount of drying agent input material required by 37 percent.[4]

Approach 3: Plant Operations

Better plant management or housekeeping can significantly reduce waste (see box 3-C). Examples of operation changes include:

- improvements in ancillary plant operations such as better predictive and preventive maintenance;

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[4] Ryan Delcambre, Dow Chemical, "Dow Chemical's Hazardous Waste Minimization and Incineration," paper presented at a League of Women Voters conference, *Waste Reduction: The Ongoing Saga*, Woods Hole, MA, June 4-6, 1986.

Box 3-C.—Waste Reduction Through Changes in Plant Operations: More Efficient Materials Handling

Since 1982 Borden Chemical Co.'s Fremont, California, plant has reduced organics in its wastewater by 93 percent through four separate changes in its handling of phenol and urea resins, as follows:

1. **Borden altered its method of cleaning the filters which remove large particles of resinous material as the resin product is loaded into tank cars. They began collecting the rinsewater instead of sending it down the floor drains and into the company's onsite wastewater treatment plant. This rinsewater can be reused as an input in the next batch of phenolic resin.**
2. **When loading urea resin, they began reversing the loading pump at the end of each load so that resin on the filters would be sucked back into the storage tank and would not be rinsed out as waste.**
3. **The company revised rinsing procedures for reactor vessels between batches. Previously, 11,000 to 15,000 gallon chambers had been cleaned by filling them with water, heating and stirring the water to remove resin residues, and then draining the rinsewater into the plant's wastewater. The plant now uses a two-step process. A small, first rinse of 100 gallons of water removes most of the residue from the containers. Then a second, full-volume rinse is used to complete cleaning. The first 100 gallons of rinsewater is reused as input material for a later batch of resin. Water from the second rinse is discharged as wastewater but has a lower phenol concentration than the previous volume of wastewater.**
4. **Procedures for transferring phenol from tank cars to storage tanks have been altered. Formerly, when the hose used to transfer the phenol from car to tank was disconnected, a small amount of phenol dripped down the drain—enough to cause problems given the strict regulatory limitation for phenol. Now, the hose is flushed with a few gallons of water to rinse the last bit of phenol into the storage tank.**

In addition to greatly reducing wastewater volumes, these changes have eliminated most of the hazardous solid wastes generated by the resin manufacturing processes because the company was able to discontinue use of the onsite evaporation pond to treat these wastewaters.

SOURCE: David Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985), pp. 97-102.

- better handling of materials to reduce fugitive emissions, leaks, and spills;
- changes in methods of cleaning equipment to avoid use of hazardous materials;
- better monitoring of process equipment for corrosion, vibration, and leaks;
- more automation of processing;
- separation of waste streams to facilitate in-process recycling;
- use of covers on tanks and other actions to reduce vapor losses; and
- more use of sensing devices to detect and prevent nonroutine releases of wastes.

For example, the Stanadyne Co.'s metal plating operation reduced waste by introducing a pause into the machine that moves parts in and out of tanks; this allowed dragout solution to drip back into the process tank rather than pollute the rinsing tank. Exxon Chemical Americas installed floating roofs over its tanks of volatile solvents, greatly reducing waste emissions. Daly-Herring Co. replaced its single baghouse system with two separate systems for two production lines of different pesticides so waste dust from each could be returned to production. As these examples show, there are many simple, low-tech opportunities to reduce waste by examining plant operations. Often only parts of waste streams are reduced, but implementation is typically quick and inexpensive. Motivated workers are the key to finding and exploiting these opportunities.

Approach 4: Process Inputs

Changes in raw materials, either to different materials (e.g., water instead of organic solvents) or materials with different specifications (e.g., lower levels of contaminants) may reduce waste. For example, Scovill, Inc., replaced the solvent 1-1-1 trichloroethane with a water soluble cleaner for degreasing applications. Riker Laboratories replaced organic solvents used to prepare coated medicine tablets with a water-based solvent and also used different spray equipment. Pilot studies have also shown that process input changes may be used to reduce wastes in mining. Nontoxic reagents have been substituted for cyanide compounds in the processing of copper ores; similarly, alkalinity of processing reagents can be maintained by using reagents less toxic than ammonia, for example lime.[5]

Frequently, changing raw materials is associated with making changes in process technology and equipment or in the composition of the end product. In box 3-D is an example of changing printing inks. Cleo Wrap, a relatively large company, made a major commitment over several years, developing a family of new inks and changing printing equipment to accept the new inks. Smaller companies may be dependent on their vendors for changes in raw materials, and vendors may not be able to make changes for waste reduction purposes unless large waste generators help them develop these new products. When the waste generators are their own raw materials suppliers, changes are much easier.

Box 3-D.—Waste Reduction Through Changes in Process Inputs: Substitution of Water-Based Inks for Organic Solvent-Based Inks in Printing

In 1986 Cleo Wrap, the world's largest producer of Christmas gift wrapping paper, completed its conversion from organic solvent-based inks to water-based printing inks in all its operations. Organic solvent-based inks required organic solvents for cleaning presses; water-based cleaning solutions and soap will now do the job. Because Cleo Wrap is so large and manufactures such a variety of color designs, ink changes and press cleanups are frequent and the amount of organic solvent being used was substantial. In 1984, the last year of the 6-year phase-in of the water-based inks, Cleo Wrap was reporting 133,555 kilograms of ignitable hazardous waste. Annual hazardous waste disposal costs were $35,000. Cleo Wrap now plans to seek status as a small quantity generator.

This substitution has had several benefits. It has made it possible for Cleo Wrap to remove all eight of their underground storage tanks, to eliminate all above ground solvent storage, to reduce or eliminate fire hazards, to seek lower fire insurance premiums, to eliminate their ignitable hazardous waste holding area, and to eliminate their hazardous waste disposal costs.

This raw materials substitution required some equipment changes and retraining of employees to work with the water-based technology because printing sequencing and drying techniques are very different. The change also required Cleo Wrap to persuade their ink suppliers to develop a full range of water-based ink colors that did not exist when the company undertook the change in 1978.

SOURCE: Award presented at Governor's Conference on Pollution Prevention Pays, Nashville, TN, Mar. 4-6, 1986.

Approach 5: End Products

Changes in the design, composition, or specifications of end products that allow fundamental changes in the manufacturing process or in the use of raw materials can directly lead to waste reduction. For example, 3M reformulated a product to use a nonhazardous organic ma-

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[5] U.S. Environmental Protection Agency, *Report to Congress: Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale*, EPA/530-SW-85-033 (Washington, DC: Office of Solid Waste, Dec. 31, 1985), p. 3-5.

Box 3-E.—Why Companies Fear Adverse Affects on Product Quality Resulting From Waste Reduction

Monsanto reformulated a specialized industrial adhesive so that hazardous particulates remained in the product, thus eliminating the need to use and dispose of filters and particulates as waste. However, the company then had to convince its customers that the particulate matter formerly removed by the filters could remain in the product without affecting its adhesive qualities. From the time the company researchers came up with the idea of reformulating the product, 2 years of effort by Monsanto's Research and Marketing Divisions was required before the reluctance of the purchaser to accept a different product was overcome and the change could be made.

SOURCE: David Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985), p. 89.

terial instead of a metal alloy in its manufacture, thus eliminating a specific cadmium-containing hazardous waste.

This approach is difficult because of constraints imposed on the product by the customer or by performance specifications (see box 3-E). Implementation may require significant and costly changes in the production technology or the raw materials. For these reasons, this is the most difficult waste reduction approach to use.

A variation on this approach was used by Dow Chemical when it changed the way it *packaged* a product. A wettable powder insecticide, widely used in the landscape maintenance and horticulture business, was originally sold in 2-pound metal cans which had to be decontaminated prior to disposal, thereby creating a hazardous waste. Dow now packages the product in 4-ounce water soluable packages which dissolve when the product is mixed with water for use.[6]

Selection and Implementation of Waste Reduction Approaches

The tendency for industry to concentrate on in-process recycling and plant operations can be explained in several ways. First, recycling and plant operation changes are add-ons. They are similar to end-of-pipe techniques that engineers use to achieve conventional pollution control goals. Thus, while these actions are part of production, they do not tend to involve major changes in process technology and equipment.

Second, recycling and plant operation changes are also often the least expensive option, rarely requiring large capital investment and usually bringing immediate returns. Although recycling can be costly to set up, the benefits of using the recycled material are relatively certain and easy to calculate. For example, the consequences of using a recycled material instead of a virgin material can be figured out in a straightforward way, such as by making trial runs with the recycled material to check the processing parameters and product quality.

Third, these approaches are easy for engineers and plant workers at all levels to identify and are relatively easy to implement. They are also unlikely to disrupt plant operations and risk product quality and, therefore, require little attention from senior management. In fact, because these approaches are so simple, management may not track them. And because they are easy to implement, they are difficult to document and unlikely to be emphasized in the literature. In sum, changing plant operations and in-process recycling usually poses little risk because neither the company's product nor its processes are significantly affected.

Changing process technology, raw materials, and end products may require intensive engineering efforts and even R&D, may pose possible risks for product quality and customer acceptance, and eventually may call for significant capital investment. Moreover, the effectiveness of these changes in terms of waste reduction may not be easily predictable. Most environmental engineers or plant operating engineers have neither the training and expertise nor the authority to implement such actions. Nor are these opportunities apparent to plant workers. To implement these kinds of changes, engineers and scientists who have been concerned solely with industrial processes and technology or with product development and design have to be given new responsibilities and have to be educated and motivated to implement change for—but not restricted to—waste reduction. Company management has to become involved, either directing the attention of such people to waste reduction, making it a major criterion for success of company R&D efforts, or getting outside technical assistance to implement waste reducing changes. Older plants and mature industries are especially likely to have significant problems and face high costs for waste reduction actions of this kind that involve significant changes in technology, major equipment, and raw materials.

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[6] Delcambre, op. cit.

Why, then, are process technology and equipment changes ranked second, both by industries in the OTA survey and in the literature? *In spite of the difficulties and risks, waste reducing process and equipment changes are sound economic investments for many companies and can improve both their efficiency and profitability.* Both the OTA survey and the literature sampled extend across a broad cross-section of industry, representing many industry types, not just the mature industries which can find process changes difficult. The popularity of process changes indicates strongly that serious, front-end waste reduction is possible in a wide variety of industries.

The Investment-Uncertainty Barrier

The fact that waste reducing process and equipment changes are frequently sound economic investments is indicated by the results of OTA's industry survey and by economic data in the literature. OTA asked respondents in 99 companies to rank nine types of obstacles to waste reduction as to whether they were "usually," "occasionally," or "rarely" a problem in their operation (see app. A). Capital costs were ranked as only an "occasional" obstacle. Waste reduction investment documented in the literature (see discussion later in this chapter) often provides economic data on costs and savings, which are virtually always very favorable and illustrate a wide variety of ways in which waste reduction measures can provide high return on relatively small amounts of capital. While such opportunities may not be available to all companies at all times, **it is clear that a large amount of waste reduction is possible and has been undertaken by companies without large amounts of capital and with high returns on investment.**

This is true now, when most companies are in the early stages of waste reduction. However, as interest in or pressure for waste reduction increases, a firm will exhaust the obvious, simple, cheap, and quickly implemented ways of achieving this goal. The amounts of capital which must be invested to achieve further waste reduction may increase. At the same time, certainty about the return on those investments is likely to decrease. Additional waste reduction efforts will increasingly require changing the fundamentals of processes and product design in new and untried ways. These more complex measures are dependent on intimate knowledge of specific, often unique, details of the plant's technology, operations, and products. Companies therefore cannot rely on outside information and the experience of others but must take the risks of experimentation and implementation themselves.

For most generators, a combination of greater resource requirements and greater uncertainty about payoff become barriers to further waste reduction at some point. However, determining when this point has been reached may be a matter of perception and opinion. When someone says his company "can't do any more waste reduction," he may be thinking of waste *management* approaches, or he may mean the company has exhausted the obvious, simple, and cheap techniques to reduce waste. To go further would require more time and money, and willingness to invest despite uncertainty about the waste reduction outcome. Moreover, some firms have trouble not only in implementing basic production technology advances but even in *finding* information about technical approaches. In such cases, lack of attention to waste reduction may be a symptom of a larger problem.

Older, troubled manufacturing industries, in particular, may encounter the investment-uncertainty barrier early on. For many smaller companies with few technical resources and with difficulties in raising capital, this barrier may be virtually insuperable. To overcome the investment-uncertainty barrier and pursue what might be the most effective means of waste reduction, industry may need strong motivation, either from within (e.g., greater tangible management support) or from outside (e.g., direct government assistance).

As will be discussed later, it is extremely difficult to estimate waste even approximately reduction potential. Hence, whether a plant-specific barrier can be reasonably overcome or whether some true upper limit to waste reduction has been reached—based on exploration of all approaches—is very difficult to resolve. It is difficult for the company's management and even more difficult for someone on the outside. On the other hand, the evolution of most production operations based on such objectives as modernization, innovation, and new product development will provide a number of added opportunities for waste reduction. But, as stated earlier, such opportunities are fewer, in mature industries.

In some sense, the evolution from simple and cheap to complex and costly means to achieve waste reduction may be happening in the Nation as a whole. This is a speculative statement because not every industrial plant is starting waste reduction at the same time or proceeding at the same pace. However, because we have had a voluntary approach to waste reduction, industrial efforts probably have concentrated on the easiest approaches to waste reduction, although some firms have progressed further. Many firms may not have had enough time yet to implement fully even the easiest forms of waste reduction, much less to consider or examine more costly approaches. Government policies and programs have not yet paid much attention to waste reduction, information and technology transfer are in early stages, and many industries are still just beginning to undertake waste reduction as an end in itself. Nor has waste reduction become a major issue for the public. This state of affairs underlines an important fact: **waste reduction's subordinate position to pollution control and to the more traditional imperatives of the production system has resulted in suboptimal levels of waste reduction.**

ILLUSTRATIONS OF WASTE REDUCTION

A Growing Literature

Waste reduction is discussed in a rapidly expanding literature from the United States and several European nations. Most publications present case study examples of successful waste reduction to illustrate its feasibility. The literature does make a case for waste reduction—both for its desirability and for its feasibility—but it is probably not very useful to other companies in their waste reduction efforts nor is it of much help to those outside of industry in assessing the transferability and limitations of the techniques discussed.

There are several reasons for the lack of usefulness. First, few accounts go into enough detail to give a thorough understanding of why and how waste reduction was carried out. Often it is not clear what waste has been reduced, how much it was reduced, by what method it was reduced, or what the costs and benefits were. Second, the number of cases reported in the literature is limited; the same examples appear over and over again. Third, comparisons between examples from one published source and another are difficult to make because there are no generally accepted definitions of wastes or reduction. Many examples deal with nonhazardous wastes, particularly in European documents; in other cases only a RCRA definition of hazardous waste is used, ignoring wastes in air and water. Similarly, waste reduction

Table 3-1.—Waste Reduction Case Studies

	Waste reduction methods						
Sources	In-process recycling	Plant operations	Process technology and equipment	Process inputs	End products	Waste management methods	Totals
a	19	16	11	5	0	22	74
b	36	0	24	7	0	15	82
c	36	0	17	2	0	10	65
d	10	4	6	2	0	4	26
e	6	10	18	2	2	1	39
f	3	0	20	1	1	3	28
Totals	110	30	96	19	3	56	314

SOURCES: Office of Technology Assessment, compiled from:

a. D. Huisingh, et al., *Proven Profit from Pollution Prevention* (Washington, DC: The Institute for Local Self-Reliance, 1985);

b. *Compendium on Low and Non-waste Technologies* (Geneva, Switzerland: United Nations Economic Commission for Europe, 1981-84), four volumes;

c. M. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986). Originally assembled and developed as *Les Techniques Propres dans l'Industrie Francaise* (Paris: The Ministre Du L'Environnement, 1982);

d. Department of Defense, Environmental Leadership Project, *Industrial Processes to Reduce Generation of Hazardous Waste at DOD Facilities*, Phase 2 Report: Evaluation of 18 Case Studies, prepared by CH2MHill (T.E. Higgins), July 1985;

e. D. Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, 1985); and

f. Federal Minister for Research and Technology (DFVLR), *Environmental Protection Technologies* (Cologne, West Germany: DFVLR, December 1984). (Note that this last volume documents ongoing research rather than industrial application of technologies.)

definitions often include what is actually waste management. Examples of waste reduction in the literature may also include simple volume reduction (e.g., dewatering of a sludge) with no reduction of hazardous content.

In order to gain some insight into the literature, OTA analyzed six references which offered the most detailed and useful accounts of hazardous waste reduction. Table 3-1 shows the distribution of case studies in these six documents across the five different waste reduction approaches available to industry. Table 1-2 in chapter 1 shows the distribution of these same cases across Standard Industrial Category (SIC).[7] Of the 314 examples included in the six sources which dealt with a broad category of hazardous waste,[8] 110 of them described in-process recycling measures, 96 describe process and equipment changes, 30 describe operations changes and 19 describe input substitutions. Only 3 of the 314 cases were end-product reformulations, which is consistent with the unpopularity of this approach among industries surveyed by OTA.[9]

The distribution of approaches in the literature is similar to the ranking of approaches by companies surveyed by OTA. In-process recycling and technology/equipment changes are by far the most common method of reducing wastes, followed by plant operations or housekeeping changes. Input substitutions are rare; end-product reformulations are by far the least common method of reducing waste. As discussed above, the recycling and operations changes have an add-on character which makes them relatively easy to implement with little risk. Process and equipment changes are usually more difficult and risky to implement, but the potential payoff for such changes in terms of increased efficiency and reduced costs can be very large. The frequency with which such changes are documented in the literature indicates that major front-end waste reduction actions are both possible and profitable for a very wide range of industries.

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[7] The distribution of cases across SICs illustrates the wide range of industries that have become involved in waste reduction. However, the distribution should **not** be taken as any conclusive demonstration of waste reduction activity or lack thereof in any particular industry. Three of the the six compendia focus on only a few or even just one (INFORM) SIC category and therefore make no attempt to be representative.

[8] Some examples in the literature deal with waste heat and with nonhazardous wastes, for example from food processing. These were not included in OTA's tally.

[9] It is worth noting that even these three are not particularly good examples of waste reduction by end product reformulation. The two INFORM examples both involve eliminating filtration of a hazardous particulate from an adhesive so that it is passed on in the product—a change of questionable overall environmental benefit. The other example in the German compendium—an investigation into possible substitution of aluminum for cadmium in electroplating—is a piece of R&D done in a university research institute, not an example of successful waste reduction in industry.

Generic Waste Reduction Opportunities

Another way to illustrate waste reduction opportunities is by examining those that apply to common hazardous wastes or industrial operations. While it is correct that there are important site-specific constraints to waste reduction, many successful practices, which generally have paid for themselves within a period of months to a few years, can be adopted by a broad range of companies and industries. Discussions of several of these practices follow.

Replacement of Organic Solvents

There are a number of successful examples of companies that have cut their costs and hazardous waste problems by changing from materials that contain large amounts of organic solvent,[10] such as inks, to ones based with water. There are also a number of examples of switches from pure organic solvents to water-based cleaning agents. This approach competes in popularity with in-process recycling of organic solvents, which is also widely applicable and on the rise, but the substitution approach is a better example of waste reduction.

Material substitution can eliminate, not just reduce, a particular waste stream and can also eliminate other problems, such as contamination from leaking underground storage tanks and worker exposure to the original solvent. However, problems with product quality may result; for example, a great deal of development was necessary before water-based paints achieved levels of color quality and durability similar to the solvent-based paints they replaced. By now there has been a record of so many successes in this type of substitution that a broad shift on the part of suppliers from organic solvents to water-based products for industry is likely, although organic solvents will continue to be considered essential or preferable in certain applications. This shift will especially benefit smaller firms that can buy the new products and cut their waste generation. There appear to be many waste reduction opportunities here, although in some industrial processes development work will be necessary, including major or minor changes in plant equipment.

Organic solvents can also be replaced by materials other than water to reduce waste. For example, Merck, Sharp & Dohme has been successful in replacing some organic solvents with inexpensive inorganic acids and bases in pharmaceuticals manufacture. They report that the substitute process has eliminated 300,000 gallons of methanol and 300,000 gallons of hexane a year in the manufacture of one product. This and other manufacturing changes reduced the company's generation of chemical wastes by 50 percent over 4 years. Recycling of 2.6 million pounds a year of methylene chloride meant a per pound savings of 24 cents for raw material costs and 35 cents for incineration.

In-Process Solvent Recovery

Solvent recovery falls within the definition of waste reduction in this report as long as the recovery equipment is used in conjunction with process equipment or within the waste generating activity area. In-process solvent recovery is widely used as an alternative to replacement of organic solvents to reduce waste generation. It is attractive because, like end-of-pipe pollution control measures, it requires little change in existing processes. The widespread commercial availability of solvent recovery equipment is another attractive feature. Availability of equipment suitable for very small operations, particularly batch operations, may make in-process recovery of solvents financially preferable to raw materials substitution for such firms, but for most companies the relative economic advantages of in-process recovery are less clear.

Commercially available solvent recovery equipment for in-plant use is summarized in table 3-2. The functioning of each of these pieces of equipment is based on one or more of the following methods:

- *Carbon adsorption* of solvent, subsequent removal of the solvent by steam, and separation of the solvent for reuse in the operation. This process works best with sol-

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[10] Organic solvents include: methanol, hexane, toluene, methylene chloride, Freons, xylene, chloroform, isopropanol, acetonitrile, trichloroethylene, and many other compounds.

Table 3-2.—Some Commercial Sources of Solvent Recovery Equipment[a]

Carbon adsorption:

AMCEC Corp. (Oak Brook, IL): Custom designed and packaged systems. A new process reduces desorption stream requirements from the conventional 3 or 4 lb steam/lb of solvent to 2 lb steam/lb of solvent recovered, or less.

Dedert Corp. (Olympia Fields, IL): Equipment and systems feature new technology to reduce energy consumption to less than 1 lb of steam/lb of solvent recovered for large-scale operations. Investment recovered quickly, often in less than 24 months.

Hoyt Manufacturing Corp. (Westport, MA): Can recover 85 to 95 percent of solvent with payback in less than 1 year.

Met-Pro Corp. (Systems Division, Harleysville, PA): Either granular or fiber carbon used.

Ray Solv, Inc. (Piscataway, NJ): Regeneration of carbon achieved by purging the adsorber with an inert gas in new system. This can reduce cost by 50 percent and energy requirements by 35 percent over conventional systems. Steam desorption system offers recovery efficiencies of 99 percent.

Vara International, Inc. (Vero Beach, FL): Uses pelletized carbon bed and automatically controlled systems.

Distillation/condensation:

Edwards Engineering Corp. (Pompton Plains, NJ): System based on direct condensation by refrigeration. Vapors are passed over cold condensing surfaces where solvent vapors condense and are collected as a liquid and returned to product storage.

Finish Engineering Co. (Erie, PA): Features one button operation and no operator requirement.

Hoyt Manufacturing Corp. (Westport, MA): Distillation system recovery efficiency of 98 percent; completely automatic, continuous process.

Recyclene Products, Inc. (South San Francisco, CA): Small volume (5 gal) distillation recovery system available.

Distillation/condensation (continued):

Pope Scientific, Inc. (Menomonee, WI): Uses a vacuum distillation process. Capacity of up to 200 gal/day.

Sauk Valley Equipment Co. (Rock Falls, IL): Can distill 15 gal/shift at a cost of 4 to 10 cents/gal.

Progressive Recovery, Inc. (Columbia, IL): Distills all common solvents up to a boiling point of 500° F with vacuum assist at a cost of 5 to 8 cents/gal.

pbr Industries (West Babylon, NY): Two portable batch sizes (5 and 14 gal) recycle 90 percent of solvent (acceptable feed includes paint thinners, aromatic hydrocarbons, chlorinated solvents) automatically in a few hours. No pressure valve; costs less than 5 cents/gal. Special additive allows sludge reclamation and production of low-cost rubberized undercoating or gravel guard.

Scrubbers, other methods, or operating principle not known:

Cailcote (Berea, OH): Scrubber uses a proprietary high boiling point organic liquid that is regenerated and recycled. Stripper column has a fractionation section and a condenser. Process is continuous.

Tri-mer Corp. (Owosso, MI): A wet scrubber system for various types of industrial sources which can be combined with other devices, such as a distillation/condensation device, for solvent recovery.

Detrex Chemical Industries (Southfield, MI): Modular approach which can be used with most chlorinated and fluorinated solvents. Many systems have paybacks of less than 1 year.

Venus Products, Inc. (Kent, WA): Systems can recover 95 percent of solvent and up to 4 barrels per shift with automatic barrel filling.

Union Carbide (Danbury, CT): Recovery efficiencies of up 99 percent in large systems which can pay for themselves in about 2 years.

[a]This table is for illustrative purposes. The appearance of a technology in this table should not be construed as a recommendation or endorsement by OTA.

SOURCE: Office of Technology Assessment, based on information supplied by companies and P.M. Cheremisinoff, *Pollution Engineering*, June 1986, pp. 26-33.

vents that are immiscible with water and when only a single solvent is being recovered. Since the carbon must be regenerated, two or more units are required to keep the operation continuous. There can be problems and costs associated with hydrochloric acid formation from chlorinated solvents, carbon bed plugging by particulates, and buildup of certain volatile organics on the carbon.

- *Distillation and condensation* are used to separate and recover the solvent from other liquids. Removal efficiency can be very high with this process. It can be used for solvent mixtures as well as single solvent streams.
- *Dissolving the solvent* in another material (i.e., scrubbing) can be used. The solvent must then be recovered from the resulting solution, for example through distillation and condensation. Efficiency of removal is often not high with this method.

Mechanical Instead of Liquid Processes

Whenever liquids are used to transfer or remove material, it may be possible to accomplish the job by a mechanical means. For example, metal beads can replace a caustic solution to remove dirt or oxide on metal parts. Some types of plating can be done mechanically rather than with traditional electroplating methods. Paint can be removed by bombardment with plastic or metal beads rather than by using solvents. Nonmechanical sources of energy can also replace liquid chemicals; for example, the Air Force has developed a high-intensity flashing light to strip paint from aircraft wings.

Preventing Vapor Losses

Often it is possible to prevent hazardous air emissions by the simplest of techniques while realizing large cost savings on raw materials. Since there are often no government regulations on control of toxic fugitive emissions, often little thought has been given to the subject, although it is easy to design equipment that will do the job. For example, Exxon Chemical Americas reduced emissions by 85 percent or more with floating roofs on open tanks of volatile materials. Other techniques include: installing condensers in or near operations to turn vapors into liquids, which are easily reused; increasing the height of vapor degreaser tanks to increase the distance between the vapor and the top of the tank; and using automatic tank covers that close between each degreasing operation. Another approach is to convert from batch to continuous process. For example, Monsanto changed polystyrene production some years ago from batch reactors to a closed-system continuous process. As a result, air emissions dropped from 5 percent of total production to less than 0.02 percent.

Reducing the Use of Process Water

Remarkably large volumes of hazardous aqueous waste result from the widespread use of water to transfer heat and materials, particularly in the cleaning of equipment in batch processes. For the most part, these wastes are extremely dilute solutions with very low concentrations of hazardous substances—so low that it is not practical to remove and reuse them. Either the aqueous waste is managed as a RCRA waste or it is put through a water treatment plant that typically either creates sludge for land disposal or releases hazardous air emissions. Historically, water has been so cheap and the costs of managing dilute aqueous wastes have been so low that it is has been used with little thought of the hazardous waste consequences. There are probably almost countless opportunities to cut down on waste created by the contamination of process water, but there are also obstacles. See box 3-F for an illustration of both the possibilities for and the limitations on reduction of wastewaters created in the manufacture of acrylonitrile.

When water is used strictly for the removal of heat, then heat pump or refrigeration systems based on circulation of coolants in a closed-loop can be used instead. The problem with using cooling water is that chemical agents are added to minimize bacterial growth and slime buildup on cooling coils; such agents may, for example, contain chromium, which eventually renders the water hazardous.

In many industrial operations water is used as a solvent but organic solvents can be so much more potent that reductions in water use of two or three orders of magnitude may be possible. The higher initial cost can be more than offset if the organic solvents are cleaned and recycled. Recycling can also facilitate removal and possible reuse of the dissolved materials. As the cost of managing hazardous wastewater increases, the use of organic solvents might increase.

Another major industrial use of water is as a medium for precipitation. The result is wastewater that may contain 1 to 15 percent dissolved hazardous inorganic salt. Precipitation for product recovery might be replaced by separation techniques such as membrane technology.

Large quantities of water are used for cleaning, and a good example of reduction is to replace high-volume streams of water for cleaning tanks, equipment, and products with systems that use much smaller amounts cyclically. Other approaches include pressurized water or drip tanks to collect chemicals rather than a water tank; counterflowing multiple rinse tanks; and squeegees to remove residues. Smaller pipes or flow restrictors will inhibit workers from wasting water. Yet another approach is to schedule batch processing to maximize back-

Box 3-F.—Possibilities for Reduction of Hazardous Water From Manufacture of Acrylonitrile

In 1985 acrylonitrile ranked 38th in the list of the top 50 chemicals made in the United States, ranked 20th out of the 26 organics on the list, and had the highest growth rate of the organics from 1975 to 1985 with an annual average rate of 6.8 percent. Production in 1985 was 2.35 billion pounds (1.1 million metric tons).[1] For each metric ton of acrylonitrile product manufactured, 2.3 metric tons of process water and 400 metric tons of cooling water are used.[2]

Process Water.—Water is used primarily as a quench neutralizer to cool the reactor effluent and neutralize any unreacted ammonia. Sulfuric acid is added to process water, and the acid solution is added directly to the quench neutralizer tower to effect very rapid cooling. Effluent from the quench tower is aqueous waste, essentially an ammonium sulfate solution. Based on the production rate of acrylonitrile, an estimated 2.5 million metric tons of process wastewater is generated annually. This is roughly 1 percent of the national hazardous waste stream. The disposal cost of the wastewater is estimated at $30 to $60 per metric ton of product based on using deepwell injection for waste disposal; the product cost is estimated at $560 per metric ton.

Possibilities for Waste Reduction.—A process technology change is difficult because the process water serves two purposes: it cools the reactor effluent and serves as the medium for neutralizing the excess ammonia. Indirect cooling via a heat exchanger would probably not be rapid enough to replace the direct quench, and use of a heat exchanger surface might lead to the formation of tars or other undesirable side reactions. Moreover, indirect cooling would not accomplish neutralization of the excess ammonia. To change the acrylonitrile manufacturing process to eliminate or reduce process wastewater would constitute a major change. A large research effort might be required with a pilot and demonstration project and might take 5 to 10 years at considerable cost. Since the cost of the process wastewater is only 5 to 10 percent of the total production costs, such an effort is not attractive. If wastewater management costs were significantly higher, say twice or three times as much ($60 to $180 per ton of product), perhaps because of shifting from injection wells to treatment, then the effort might be justified.

Cooling Water.—For every gallon of cooling tower water circulated, a small fraction called blowdown is discarded to remove the buildup of slime and solids which accumulate during recirculation. This blowdown contains toxic chemicals used as bactericides and fungicides and is a hazardous waste. A typical blowdown ratio is about 0.5 percent of the circulation rate. For each 400 metric tons of cooling water used per ton of product, 2 metric tons of blowdown wastewater is generated. Thus, about 2.2 million metric tons of this wastewater is generated annually. Disposal cost of the wastewater ranges from about $26 to about $52 per metric ton of product, or 5 to 10 percent of product cost.

Possibilities for Waste Reduction.—Here the water serves only one function, cooling. An alternative could be the use of a heat pump cycle to reject heat to the environment from a closed-loop coolant refrigeration system. After the coolant was used to cool the process, it would be compressed to a higher temperature and pressure and then passed through a radiator that would reject the heat to the environment. The operating costs for cooling would be from $17 to $60 per metric ton of product.[3] The costs for managing the traditional coooling wastewater, if injection well costs are from $0.05 to $0.10 per gallon, are $26 to $52 per hour per ton of product. (This cost could increase if a waste management shift occurred from deepwell injection to waste treatment.) There is a clear potential for saving perhaps $20 per ton of product if closed-loop, efficient refrigeration were used instead of conventional water cooling. For a 100,000 ton per year plant this means a saving of about $2 million annually. Assuming that the capital costs of the refrigeration system might be at most about 10 percent of the original capital costs of the plant, $50 million, then payback would occur in a few years.

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[1] *Chemical & Engineering News*, Apr. 21, 1986.

[2] *Hydrocarbon Processing*, May 1977, p. 171. Data based on Montedison-UOP process, which differs from the more widely used SOHIO process primarily because of a different catalyst. However, similar water use and wastewater generation can be assumed for both.

[3] The operating costs can be estimated making the following assumptions: 1) cooling water temperature rise of 12° F. 2) coefficient of performance ranges from 2 to 7, and 3) energy costs are $0.04 per kilowatt-hour.

to-back production of products, thereby minimizing washdowns.

In many of these approaches a smaller volume of water with more highly concentrated contaminants is generated. This water sometimes can be directly recycled into production systems or can be economically treated to recover valuable components, such as metals and oils, for recycling back into the process. For example, Borden Chemical Co. stopped filling reactor vessels with water to clean them and instead used 5 percent of the previous volume for the initial rinse, allowing a concentrated solution of phenol resins to be recycled back into production.

There is an array of technologies under development to separate and remove valuable substances from wastewater. These include: membrane technologies such as electrodialysis, reverse osmosis, ultrafiltration, liquid membranes; adsorption technologies that use a variety of materials such as activated carbon; and bubble and foam separation. One or more of these techniques might be applicable to a particular waste stream.

Another important aspect of recovering contaminants is that many of these technologies allow the use of closed-loop systems in which process water is recycled rather than being passed through the system a single time. In some locations, such approaches are attractive simply because they drastically cut water consumption. Moreover, this approach can eliminate the generation of large amounts of sludge in water treatment plants.

Many different types of industries, not merely the chemical industry, could explore opportunities to reduce wastewater volumes. For example, a recent development concerns spent metalworking fluids. After 4 years of laboratory research and field trials, Eaton Corp. installed a patented system in a number of locations to totally recycle its metalworking fluids in-plant. All this spent metalworking fluid, which contains 95 percent water, is reused and it is claimed that the system can be used anywhere, regardless of operating conditions. Presumably the system will be marketed to other companies.

The Limits of Examples

Hundreds of case studies and examples of waste reduction in the United States and abroad document the technical feasibility and economic benefits of a variety of approaches in a wide span of industries. Yet it is difficult to know whether individual examples and case studies represent the rule or the exceptions in current industrial practice. It is a situation in which those who have achieved success are encouraged to speak of it publicly, while those that have not remain silent.

In many of these published examples no data or very limited data are given on the total waste context in which one or more specific wastes were reduced, and if any data are given for actual waste reduction they are hardly ever given in terms of production output or environmental risk reduction. It is not always clear whether some of the waste is not simply being transferred from one environmental medium to another or whether a new hazardous waste is being generated in place of the old one.

An unfortunate limitation of waste reduction examples is that the generic opportunities are often not recognized. A reader notes the particular industry being discussed and if it is not his industry, he needs imagination to see that the waste reduction method might still be applicable. If the examples were redrafted to put them into functional or general terms it might be easier to transfer waste reduction measures across industries.

Most importantly, the literature contains next to nothing about *failed* waste reduction efforts, nor does it provide detail on how problems were solved in cases that were ultimately successful. Moreover, human and organizational factors that went into a waste reduction decision are rarely discussed, even though these can be as instructive as technical and economic information. Rarely is there attention paid to which internal or external factors, such as corporate policy or government regulations, had a major role in the success of the effort.

Overall, the waste reduction literature and conversations with people in industry point to two conclusions: first, that waste reduction is

widespread, diverse, substantial, and economically justified; and second, that more can be done. Traditionally, waste reduction has been considered only as a consequence or byproduct of work to improve yields and efficiency. As was the case with energy conservation, once waste reduction becomes a major industrial goal and a criterion of industrial efficiency in its own right, opportunities not previously considered viable will be acted on and new opportunities for waste reduction will be identified.

INDUSTRY DECISIONMAKING ABOUT WASTE REDUCTION

There is no standard method by which companies make decisions about waste reduction. For the most part, waste reduction has been carried out on an ad hoc basis. A troublesome or costly waste is identified and specific action is undertaken to reduce or eliminate its generation. Wastes are often reduced by process improvements in which waste reduction is only a minor consideration. However, as waste reduction begins to appear and rise on the agendas of CEOs as an issue in its own right, systematic audits are beginning to be developed to guide comprehensive waste reduction.

Conducting a Waste Reduction Audit

Waste reduction audits are distinct from environmental audits. Environmental audits are compliance audits—they are internal reviews of a company's operations aimed at meeting environmental requirements such as RCRA and the Clean Water and Clean Air Acts.[11] **Waste reduction audits are systematic, periodic internal reviews of a company's processes and operations designed to identify and provide information about opportunities to reduce wastes.** They provide a useful tool for companies undertaking systematic, comprehensive waste reduction.

Such a comprehensive examination of operations requires a broad scope of expertise, probably beyond that of any one person in a company. Review of all processes and operations for all five types of waste reduction opportunities requires familiarity, not only with environmental requirements and waste management activities, but also with process engineering, operations, and product design. A waste reduction audit is best carried out by a group of people, each one with expertise in a different one of these areas; an environmental engineer alone cannot do it.

Involving people from different parts of the company in the waste reduction audit has the added advantage of increasing consciousness of the need for waste reduction. It can stimulate employees to think about methods of reducing waste and help shift thinking away from the pollution control focus.[12]

The comprehensiveness of waste reduction audits and the types of actions that will emerge from them also depend heavily on the way terms are defined. Depending on how waste reduction is defined, the audit may or may not review waste in all environmental media, focus on reduction of waste generation at the source, and measure reduction on a product output basis.[13]

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[11] For more information on environmental auditing see, U.S. Congress, General Accounting Office, *HAZARDOUS WASTE: Federal Civil Agencies Slow to Comply with Regulatory Requirements* (Gaithersburg, MD: May 1986), pp. 51-59. Also, U.S. Environmental Protection Agency, "Environmental Auditing Policy Statement," 50 Federal Register, Nov. 8, 1985; K. Geiser, "Critical Elements of a Waste Reduction Plan," paper presented at Government Institutes Conference on Hazardous and Solid Waste Minimization, May 8-9, 1936, esp. p. IV-10; and M.A. Smith, *A Handbook of Environmental Auditing Practices and Perspectives in North Carolina* (Chapel Hill, NC: Institute for Environmental Studies, 1985).

[12] See D. Huisingh, et al., *Proven Profits from Pollution Prevention* (Washington, DC: The Institute for Local Self-Reliance, July 1985), p. 15. A hierarchy for pollution prevention strategies is also presented here which places waste audits at the top.

[13] Very often, waste reduction audits are based on the EPA term *waste minimization* which gives equal status to reduction and recycling and so will identify such actions as equally valid options, regardless of which poses a greater environmental risk. Often, too, waste reduction audits concentrate on RCRA wastes or wastes destined for land disposal and review other emissions only incidentally. These two problems are exemplified by the

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Because waste reduction audits are new, they take a variety of names and forms. Among companies that have started auditing, each tailors its review to its own peculiar needs. Consulting firms that have begun marketing waste reduction auditing each packages its procedure a little bit differently.[14] However, OTA was able to identify a series of basic analytic steps in most systematic audits. The order of the steps may vary and two or more may be combined, but each of these points must be considered in any comprehensive and systematic waste reduction analysis.

Step 1: Identification of Hazardous Substances of Concern in Wastes or Emissions

This analysis may be done at radically different levels of detail.

Level I:—Companies may make only a very gross analysis of the contents of their wastes. This occurs commonly in some small businesses which may not have the people, money, or knowledge to conduct detailed analyses and collect detailed data. In practice, this stage of review may be no more than the realization that a company is wasting a great deal of a chemical. The focus in such cases is on quantities of particular wastes.

Level II:—Companies may systematically conduct chemical analyses of all their wastes over a given time (especially important in batch processes where wastes vary) to get more precise data about both chemical composition and amounts of waste. The difficulty here lies in identifying and measuring *all* wastes, including all fugitive emissions, leaks, and spills.

Level III:—Companies can do mass balances on hazardous substances. By subtracting the amount of a hazardous substance going out in the product from the amount purchased as raw material (and taking into account reaction processes and products), a company should be able to calculate how much of the substance is generated as waste. However, accounting for all of the waste streams, emissions, leaks, and spills in the operations usually requires a great deal of time and many resources, and such procedures are generally considered only when an action is required on a particular substance of concern. Even for a small manufacturing operation, compiling and updating mass balance information on even one hazardous substance in the plant can be a big job. Moreover, no information specific to a process may be obtained from a mass balance done on a plant basis. Chapter 4 discusses in more detail practical difficulties with conducting mass balance calculations of sufficient sensitivity to be useful for waste reduction.

Step 2: Identification of the Source(s) of the Hazardous Substance(s) of Concern

Identifying the process source of the waste for a specific product is essential. **Without knowing which processes are generating which wastes a company cannot know what actions are required to reduce those wastes.** Uncovering this information may take time and resources and may be made more difficult by accounting methods a company uses. If waste management costs, for example, are routinely charged to some general environmental operation, then the connection between waste and production process and product may not be apparent.

Step 3: Setting Priorities for Waste Reduction Actions

Companies must decide which types of waste to target for reduction and at which points in which processes. In practice, this may be an independent, external decision directed for example, by government regulations, rather than a free choice. In the absence of external determinants, recognition that a waste is environmentally hazardous may also play an important role in waste reduction decisions. To assist

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waste reduction audit procedure found in C.H. Fromm and M.S. Callahan, "Waste Reduction Audit Procedure—A Methodology for Identification, Assessment and Screening of Waste Minimization Options," paper presented at a Hazardous Materials Control Research Institute conference, Atlanta, GA, Mar. 4-6, 1986.]

[14] See, for example, R.B. Pojasek, Chas. T. Main, Inc., "Conducting a Waste Minimization Audit," *Hazardous and Solid Waste Minimization* (Washington, DC: Government Institutes, Inc., May 1986). Also, M.R. Overcash, *Techniques for Industrial Pollution Prevention* (Chelsea, MI: Lewis Publishers, Inc., 1986), p. 15.

proper economic evaluation of the costs of waste generation and management and the savings from waste reduction, waste generation should be measured on a production output basis. Not putting costs and savings on a product basis could lead to poor business decisions. For example, what appears to be a relatively small waste management cost for a waste may be otherwise when assessed in relation to a small profit margin for a product and vice-versa.

Step 4: Analysis and Selection of Technically and Economically Feasible Waste Reduction Techniques

After a waste is targeted for reduction, the problem of choosing one or more feasible waste reduction techniques remains. Different techniques will offer different levels of effectiveness at a different cost and at differing levels of risk. If there is no pressing reason to reduce one waste rather than another, companies may decide to take action first on the wastes that are the easiest and least costly to reduce and postpone the more difficult waste reduction problems for later. A great deal depends on the information base obtained, the technical resources, and the economic circumstances of the particular firm.

Step 5: Economic Comparison of Waste Reduction Alternatives to Waste Management Options

Once attractive waste reduction alternatives have been identified, they still must be proven preferable to pollution control. In most companies, waste management is the known, safe option that provides a clear result for an investment and creates minimal disruption and risk to production operations. For most firms, waste reduction is a newer approach that has the potential for widespread effects including interference in process operations and possible alterations of product quality. Waste reduction may, therefore, be perceived as economically risky by industry decisionmakers.

Step 6: Evaluation of the Progress and Success of Waste Reduction Measures

This step is critical to the disposition of the company to take further action to reduce waste. Companies must document both the benefits and costs of waste reduction, if they are to make informed decisions about whether to take further waste reduction measures. Obtaining data regularly on waste generation on a production output basis is the best way to evaluate the technical and economic success or failure of waste reduction.

Constraints and Incentives Affecting Waste Reduction Decisions

Proven technologies and the opportunities industries have for waste reduction do not themselves guarantee these technologies will be used. Factors that affect the ability and willingness of companies to implement waste reduction measures include:

1. the nature of the company's industrial processes,
2. the size and structure of the company,
3. technology and information available to the company,
4. attitudes and opinions that affect company operations,
5. the economics of waste reduction, and
6. government regulations.

Whether these factors serve as constraints or incentives for waste reduction will vary even among different plants within the same company.

Because the Federal Government's current waste minimization program is *voluntary* (see ch. 5), the degree to which these factors motivate or deter industry from waste reduction has determined the amount of waste reduction accomplished to date. Understanding these constraints and incentives is therefore essential for formulating Federal policy. They will affect regulatory options, for example, because the economics of waste reduction in different industries may influence the decisions government makes about mandating levels of waste reduction. However, these elements of industrial decisionmaking are particularly important in assessing nonregulatory Federal policy options. Nonregulatory programs rely on persuasion rather than on coercion to influence decisions.

The following analysis attempts to shed light on: 1) the relative importance of these factors in different situations, 2) the relationship among these factors, and 3) opportunities that may exist for government to manipulate these incentives and constraints to influence industrial decisions about hazardous waste reduction. The analysis must be prefaced with two points about industry decisionmaking.

First, decisionmaking procedures in industry vary greatly; generalizations of the type presented here will inevitably invite exceptions. This discussion deals with only a few of the most important and influential elements in industry decisions. A wide variety of other considerations may also shape the decisions in a particular company.

Second, change represents risk. If business is going smoothly, the inclination is not to make changes unless there is some clear reason to do so. However, if an industry is in trouble, there may also be resistance to innovation. Resources are likely to be concentrated on the obvious threats to survival rather than on making changes for waste reduction. Thus, in general, *the burden is on the proponents of waste reduction to justify change.* If the case for waste reduction is not made clear to the industrial decisionmaker, waste reduction will not happen.

Nature of Industrial Process

The most important factor in the ability of any company to reduce its generation of hazardous waste is the character of its industrial processes. These determine the waste reduction opportunities that will be appropriate and applicable (see table 3-3). There are more opportunities for waste reduction in some industries and some processes than in others. Several features of industrial processes can be identified which affect the probability that waste reduction opportunities will be available.

First, the frequency with which operations and/or processes must be redesigned for routine business reasons is important. For example, some manufacturers of consumer products are under pressure to put out new product designs frequently. Most product changes require some type of operations change; frequent prod-

Table 3-3.—Potential for Waste Reduction Opportunities Across Different Industry Types

Company/industrial characteristic	Example industries	Operations changes	In-process Recycling	Process changes	Input substitution	End product changes
Mature process technology, high volume product	Rubber Petroleum Commodity chemicals Paper products Lumber	+	+	−	−	−
Very stringent product specifications or high product quality demands for high cost/high profit products	Pharmaceuticals Weapons Robotics Specialty chemicals	+	−	−	−	−
Frequently changing, high-tech products for industrial use	Electronic components Medical equipment	+	+	+	+	−
Job shop processing of many different industrial products	Electroplating Printing	+	+	+	+	−
	Foundries Machine shops	+	+	−	+	−
Changing production technology for commodity goods	Steelmaking Nonferrous metals Textiles	+	+	+	−	−
Large-scale manufacture of consumer goods	Automobiles Appliances Consumer electronics Paints	+	+	+	+	+

SOURCE: Office of Technology Assessment, 1986.

uct reformulation makes a company conscious of its daily operations and of opportunities to reduce waste without endangering the new product design.

However, the relationship between product reformulation and process change (which tends to be harder to implement than operations changes) is more complex. Product reformulations may not require process changes. For example, changing the circuit design for a new model of a company's personal computer does not change the requirements for plating and etching, which produce most of the industry's waste. On the other hand, some product changes do involve a different process, such as those that require completely different materials. A manufacturer of home appliances, for example, may take advantage of the introduction of a new model of blender to switch from chromium plating on the machine casing to a nickel plating or to a plastic unit. Some of these alterations may eliminate one hazardous waste, but produce a new one.

It is even possible that product redesign may force changes that create more waste or more hazardous waste than previously. The semiconductor industry is starting to use gallium arsenide (GaAs) semiconductors in some applications. GaAs semiconductors are faster and use less power than their silicon-based counterparts. The manufacturing processes are similar to those for silicon products, but the introduction of arsenic, a known human carcinogen, increases the hazard of the wastes and increases the hazards in the workplace.[15]

Despite opportunities offered for waste reduction, it is unrealistic to expect businesses to redesign products or processes except under pressure from the marketplace or when impelled to do so in order to comply with government regulations. Redesign of a product or a process is expensive and risky. When the market for a product expands, requiring additional plant facilities, process change may become more feasible. For example, this has happened at times in the specialty chemicals industry where some firms have set up new production lines for chemicals in high demand.

In some mature industries such as petroleum refining and commodity chemicals, where there is little call for product or process change, opportunities for waste reduction may be limited. In other mature industries, intense competition from overseas has stimulated the use of new but proven processes that permit the manufacturer to make a better quality and less expensive product. The textile and steel industries are cases in point. However, even in mature industries with little potential for process and product change, opportunities for operational changes and in-process recycling may exist and may offer broad benefits beyond waste reduction. They may not, however, be pursued because of limited resources and other pressing needs that have higher priority.

Another industry characteristic affecting waste reduction opportunities has to do with the product quality. Cases in which the market demands very high quality, as in pharmaceuticals, may provide fewer opportunities for input substitution or in-process recycling. Operations in these plants may also produce large quantities of substandard product waste because of the quality demands on the product. High-quality products generally carry both high costs and profits, making such industries less sensitive to waste *management* costs and reducing economic incentives for waste reduction.

It may also be difficult to find less-hazardous or nonhazardous raw materials for the manufacture of some high-performance machinery. Water-based paints are now being used in many applications since they eliminate the need for solvents which then become hazardous wastes. While these paints may be perfectly adequate for many household appliances, they may not be adequate for the stresses placed on high-performance machinery, such as jet aircraft.

Product quality is by no means a consideration only for specialized industries (see box 3-E). One major automobile manufacturer recently considered installing a huge countercurrent rinsing operation in a new plant to save water and cut down on aqueous wastes from painting. Prior to painting, auto bodies are dipped in successive baths which clean the metal of dirt and oil, apply a zinc phosphate coating to increase paint adhesion, and apply a chromium anti-corrosion coating. Between baths the car body is rinsed with a water spray. This is usual practice in both this auto firm and among its competitors. When designing a new plant in an area of scarce water, it was proposed to conserve water with a counterflowing rinse. The idea was rejected in part because the company was unwilling to risk problems such as paint peeling and nonadhesion which might occur if the new rinsing procedures were less thorough than previous procedures. The company decided that even if the procedure promised to perform as well as the old method after a shakedown period they were unwilling to risk any interval of even slightly lower product quality. They feared jeopardizing their standing in a market where foreign competition has made quality a major issue. This example is also an illustration of the problem of making changes in a production line that must perform without interruptions.

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[15] Susan Sherry, et al., *High Tech and Toxics: A Guide for Local Communities* (Washington, DC: Conference on State and Local Alternative Policies, October 1985), pp. 109-112.

Another aspect of product quality which may influence the ability of companies to modify processes is the degree to which manufacturing processes are dictated by product specifications. The Department of Defense (DOD) often specifies manufacturing processes in its contracts as a means of maintaining quality in its high-performance equipment. These specifications are usually based on design work done by the DOD contractor and on extensive field testing of products. Opportunities exist at the design stage for the manufacturer to incorporate less waste-intensive features into the process. However, the procedure for modifying DOD specifications is so slow that even if a contractor discovers less waste-intensive methods of manufacturing products of equal quality, he almost certainly will not be able to implement them within the time of his contract. Hinderances to the use of new waste reduction techniques also arise from the fact that many types of DOD equipment stay in production for 20 years or more.

Rigid DOD specifications also raise the question of what level of quality is really necessary. For example, DOD requires cadmium plating on many of its aircraft parts since it is less subject to corrosion than the more common nickel plating. However, cadmium is a particularly hazardous material and from an environmental perspective it would be beneficial to substitute nickel or some other material wherever possible. A review of required performance levels *at the front end of the product-design process* might eliminate the need for some of this cadmium. A review of all DOD specifications might eliminate the need for other hazardous materials.

DOD has recognized the barriers its specifications place on waste reduction efforts and is currently reviewing this problem as part of its waste minimization efforts (see ch. 5).

Similarly, the Food and Drug Administration places product formulation and process requirements on pharmaceuticals manufacturing. Government regulators are slow to grant permission for process modifications or input substitutions in this area.

Size of Firm/Corporate Structure

The size of a company and the way it is structured strongly influence the way it makes all decisions, including those about waste reduction. Small businesses tend to have fewer people involved in decisions about waste, and those people are more likely to be familiar with the processes and wastes in question. In an electroplating shop employing 60 people, for example, a plant manager and company president or owner are likely to make all the decisions about wastes themselves and to implement change without extensive memo writing, instruction manuals, or clearance from superiors.

In large businesses, on the other hand, people intimately familiar with the processes are often far removed from those with the power to make decisions about plant operations and process change. Communication between groups in large corporations can be an important barrier to implementation of waste reduction measures. Decisions and plans made at the corporate level to reduce waste may not be well communicated or well implemented at the plant level, particularly if these plans have been formulated with little coordination at the plant level. Another problem in large companies is that environmental engineers are most often assigned to the end of the process where they *manage* the wastes that are produced, and it is usually they who are given responsibility for waste reduction despite the fact that they have little contact with the design engineers and researchers who lay out the process at the front end. Similarly, plant process and operations people may have only limited contact with those responsible for major process and product changes.

The number of people involved in decisionmaking differs from one company to another. Small firms are likely to make informal decisions, relying on their own professional judgment and experience since they are unlikely to have the resources to undertake extensive quantitative assessments of alternatives. In large corporations decisions are made or approved by many people of diverse knowledge and background who are often only peripherally familiar with the technology involved. The need to convince nontechnical managers that waste reduction measures are desirable and can be financially justified requires quantifiable (i.e., economic) analysis. Large businesses are therefore likely to make waste reduction or any other environmental decisions slowly, to conduct assessments of waste reduction options, and to formulate plans, programs, and goals before implementing them. There are no data to prove that either of these decisionmaking styles is intrinsically more or less favorable to waste reduction.

Among larger companies structure also affects how decisions are made. Some companies are very decentralized. Each plant manager can make major process and operations decisions without corporate approval. In other companies, corporate headquarters govern many aspects of the day-to-day running of individual plants. Again, neither of these situations is necessarily more or less favorable to waste reduction, but the diversity does mean that different companies may be constrained in different ways. A decentralized company may have a strong corporate policy commitment to waste reduction, but if plant managers feel there are insufficient incentives, reduction is unlikely to occur or will be implemented only slowly. Similarly, if a plant manager in a centralized company is more interested in reduction measures than are corporate managers and perhaps other plant managers, reduction measures are unlikely to occur.

Technology and Information Available

Industry type and company size affect to what extent new technology and information will be available to a company. In some industries a great deal more information about waste reduction techniques and technologies has been developed than in others. Company size, and to some extent industry/process type as well, affect whether a company can develop information and technology in-house when it is not available elsewhere. As mentioned earlier, significant change in company operations for waste reduction is risky. Firms, therefore, look for techniques and technologies that have been successfully demonstrated and used elsewhere, unless the alteration under consideration can easily be tested or implemented. There are more proven measures for some types of processes than for others. A small but growing number of vendors and consultants offer equipment and services for waste reduction. Increasingly, sellers of waste reduction services are or were waste generators who have successfully developed procedures in-house and are profitably selling their expertise and equipment to others.

Development and marketing of transferable technology is likely to occur among small firms which run generic operations and which are regionally based and therefore not in direct competition. For example, printing firms and electroplating job shops that do not compete but serve discrete local communities are industries likely to market waste reduction techniques. Proprietary concerns frequently inhibit this kind of technology transfer, particularly when firms compete directly for the same customers. This is often the case in industries where there are only a few large producers and markets are national. Commodity chemicals, for example, has always been a very competitive industry. However, larger producers are likely to have their own R&D facilities to develop technologies in-house (see discussion below).

The dissemination of waste reduction technologies and techniques is more complex than transferring established pollution control technologies to comply with the Clean Water or Clean Air Act. End-of-pipe control usually requires a fairly limited set of solutions, often involving installation of an off-the-shelf piece of equipment. Waste reduction, on the other hand, may involve a diverse set of techniques applied at the front end to processes or equipment or within operations. A relatively small number of reduction techniques are generic enough to be transferred with simple off-the-shelf equipment or standard prescriptions. When available, this equipment may only have the capability of reducing a limited number of wastes at a plant and these may not be the wastes that occur in the highest volume or are the most hazardous.

There is, however, a large body of literature about waste reduction in a wide variety of industrial processes, but technical assistance within a plant may be necessary for implementation. Only the least complex reduction ideas (e.g., housekeeping changes) are likely to be directly transferable to other plants. However, most of the process change literature is inadequately detailed and very few industrial operations are so generic as to allow direct implementation of waste reduction measures from published materials without significant inhouse research and experimentation. However, the sharing of information remains important, and just hearing about another firm's successful action at a conference or through a publication may be helpful.

Most waste reduction measures documented by OTA have been the result of some in-house research and development, tailoring techniques to the needs of a particular operation. However, only large firms are likely to have the money and, more importantly, the technical people to embark on large R&D programs to solve their waste reduction challenges. Smaller firms may have limited R&D facilities, particularly in industries such as specialty chemicals where some amount of R&D goes on as part of business.

One common obstacle to waste reduction in many smaller companies is that they purchase much of their technology and raw materials from larger companies. Small printing companies cannot begin using water-based inks until a major supplier brings them out on the market. Manufacturers of machinery are dependent on their suppliers to develop a quality lead-free paint before they can eliminate their lead wastes.

Small firms trying to avoid or reduce hazardous waste generation need information about the chemical contents of raw materials from suppliers. Instead of listing the chemicals in the raw materials, labels may simply state that: "contents are proprietary." Unless they know what is going into their processes, users cannot screen inputs for unnecessary hazardous constituents that may later appear in their wastes (or products). For example, a small firm making caulking compounds and sealants that does not generate hazardous waste ordered a raw material from a supplier. The firm specified that it did not want the material if it contained formaldehyde because formaldehyde would render the firm's waste hazardous. When the material arrived the label contained no information about constituents, but testing proved that the material did, indeed, contain formaldehyde. Another firm might not have had the resources or the foresight to test.

The labeling problem has been somewhat alleviated by the institution of OSHA worker right-to-know measures which require that all vendors supply buyers with Materials Safety Data Sheets (MSDS) detailing all hazardous constituents. OTA has heard some complaints about lack of specificity on some MSDS, but this requirement now gives buyers information (or allows them to demand information) vital for waste reduction and waste management as well as for worker safety.

Attitudes and Opinions Affecting the Company

Although there is no way to predict attitudes of top-level decisionmakers in a company, it is unquestionable that personalities and personal attitudes do have an important effect on implementation of waste reduction. This is particularly true in small companies where a company president or manager may be personally interested in hazardous waste problems and become a leader in the field. Even among large corporations, it is clear that some companies are more or less well disposed toward expending resources on environmental protection or waste reduction, viewing these goals as essential to the health of the company. A few companies, notably 3M, have gone so far as to articulate and publicly support pollution prevention as an alternative to pollution control and in so doing have created a positive attitude throughout the company toward waste reduction.

Lack of awareness about and commitment to waste reduction may influence actions involving waste at all levels of company operations. Environmental engineers can be blinkered by their experience with waste management. Environmental protection has been equated with pollution *control* for so long that many environmental engineers may not think of waste reduction as a serious near-term, economically beneficial option for solving waste problems. Even if environmental staffs are interested in waste reduction, they frequently are devoting all their time and resources to keeping the company in compliance with pollution control regulations.

Worker training is essential to educate people who operate processes about practices which create less waste. These may include simple things such as not leaving faucets running and avoiding spillage. Some larger companies have already put together videotapes aimed at educating all levels of people in the company about the importance of reducing waste.

Opinion outside the company may also influence waste decisions made within the company. Public opinion is important at a local level—in the siting of plants dealing with hazardous materials—and at the national level, as public fear about hazardous wastes increases pressures for better waste management and waste reduction. People in industry often feel that these fears are overstated or unjustified and may feel frustrated in their attempts to ally public fears about hazardous materials. The information the public receives about industrial hazardous waste is usually focused on accidents and Superfund sites and is overwhelmingly negative. Positive information about advances in waste management or waste reduction rarely make front page news. In addition, many of the horror stories about hazardous wastes, particularly at Superfund sites, came about because of waste handling practices of the 1950s, not the 1980s. Thus, despite their desire to calm public fears, industry decisionmakers often feel that they have little to gain by compiling and presenting information about successful waste reduction and management programs for the public. On the other hand, some companies *have* used waste reduction as an opportunity to portray a more positive image of their company for the public, and more may do so. Finally, some firms are committed to the siting of new hazardous waste management facilities and waste reduction may be perceived as a threat to siting; much depends on the extent to which waste reduction is perceived as a near- or long-term opportunity.

Economics of Waste Reduction

Economics is the driving force for most business decisions, and waste reduction decisions are no exception. Assessment of financial costs and benefits can act as either an incentive for or a constraint on waste reduction depending on a company's or a plant's circumstances. If an operation's waste management costs are high and it finds that it can institute significant waste reduction measures with relatively low costs, thereby saving on waste management expenditures, the company will be inclined to reduce waste. If, on the other hand, waste management costs are low relative to total costs or if costs (e.g., cleanup liabilities) are not immediately born by that operation, a company may decide not to disrupt or put at risk its processes, operations, and products with waste reduction, even if some relatively easy, low-cost reduction measures are available. The outside analyst generally does not attempt to estimate the economic consequences of such disruptions and risks and for this reason the costs of waste reduction may be perceived in a more positive light than is warranted.

According to the respondents to OTA's industry survey, the rising costs of waste management and associated liabilities for waste disposal are the primary considerations of companies that plan to implement waste reduction. These considerations are more critical to industries in which waste management costs are a high proportion of operating costs or of profits. Examples include electroplating, steelmaking and commodity chemicals, and companies that have already experienced substantial penalties for past waste management practices. Industries in which management costs are a low percentage of operating costs are less likely to be sensitive to high waste management costs. Even for generators whose current costs are not large, the threat of future liabilities may raise the specter of enormous long-term costs of waste management. But these liabilities are usually speculative and may be discounted in terms of present dollar value or may be given less importance because management believes that changes in government policy may reduce them.[16]

On a more day-to-day level, the accounting procedures companies use for waste management costs affect the ways in which waste reduction decisions are made. Particularly important is the degree to which companies assign waste management costs (including liability costs) to the processes or plants which produce the waste. If a company has an onsite waste treatment plant with its own budget and all processes within the plant send their waste there and are not accountable for that management cost, process engineers and supervisors have little incentive to examine their operations for waste reduction opportunities. If, on the other hand, companies trace waste back to the processes generating it and incorporate waste management costs into the process manager's budget, the people who are intimately familiar with the process have an incentive to search for ways to reduce the amount of waste generated. Thus, to the extent that *total* waste management costs are strictly accounted for as *production* costs, they will act as incentives for investing in waste reduction.

Accounting procedures may also influence the probability that waste reduction measures will compete successfully for limited company funds. The way in which return on investment is calculated and the extent to which and the way in which waste management costs are incorporated into investment calculations will influence the amount of capital investment and, therefore, the kinds of waste reduction measures a company is likely to take.

This competition occurs on two levels. First, environmental programs, in general, and waste reduction programs, in particular, must compete with all other potential uses of an operation's limited capital funds. If a firm is faced with choosing between investing in a new product line, purchasing less labor-intensive equipment for its current processes, or making process alterations which will reduce waste, a firm may calculate that it will get a better return on investment from one of the first two options than from the waste reduction option.

Further, most operations have a single budget for environmental programs and this includes waste reduction. In such operations waste reduction must compete with waste management and compliance programs for funds and attention. Waste management options are often difficult to compete with when reasons for implementing them are painfully clear, as in a firm that is being threatened with citations for noncompliance with pollution control regulations. In addition, waste management presents a clearer, surer investment option in the eyes of most generators who see off-the-shelf pollution control equipment and operations changes as proven. Waste reduction options are usually newer, methods may be unproven, and the results unpredictable.

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[16] One example of a change in government policy which may reduce liability is EPA's current reexamination of the definition of hazardous waste under RCRA. Some generators may believe that their wastes will not be hazardous under the new definition and may therefore not be willing to invest much effort in reducing their generation.

The uncertainty about the costs of implementing waste reduction measures is critical to decisionmakers who want reliable figures on waste management savings, labor, capital and operating costs, as well as on the costs or savings in raw materials resulting from the waste reduction measure. However, changes at the front end of an operation tend to have ripple effects throughout, and quantifying all of these effects and their costs or savings can be extremely difficult. Isolating waste reduction may result in smaller benefits, while seeing it as part of a broader innovation or change in production may increase its costs. Clearly, there are ways to make waste reduction appear more or less attractive economically. Since, as noted above, decisionmakers in business tend to avoid unnecessary risk, the difficulty in coming up with firm figures on waste reduction investments handicaps them in competing for limited company dollars.

Government Regulations

Despite widespread noncompliance and complaints about ineffectiveness, environmental regulations significantly influence the ways businesses make decisions about waste. These regulations may be of two types; they may directly require that business take action or they may affect the environment in which businesses make decisions. Probably the most influential government measures to date have been of the latter variety, such as the joint and several liability for Superfund sites and the enactment of land disposal bans in the 1984 RCRA Amendments. Both of these measures hit directly at the financial calculations which determine waste-related decisions.

Industry responses to government requirements for environmental action vary with the size and structure of the company as well as with more intangible factors like plant management and corporate attitudes. Small companies are less likely to have the resources and personnel to keep up with all of the details of government regulation and may simply throw up their hands and hope that their small size will make them unlikely targets for enforcement. Large corporations that may have other reasons for believing that enforcement may not occur still usually have environmental compliance staffs assigned to keep track of regulations. The job of these environmental engineers, however, is environmental *compliance* and pollution control, rather than environmental protection or pollution prevention in the larger sense. This distinction bears directly on the ways in which large companies currently make decisions about waste reduction. Environmental engineers in large companies sometimes say that they have trouble getting support from management for environmental actions which are not required by regulations, such as audits to trace waste to processes.

Current environmental regulations may have handicapped waste reduction in several ways. First, the existing elaborate framework of pollution control laws has become the center of the environmental protection arena. Control laws are both established and—in theory, if not always in practice—enforceable. The waste minimization program set up in the 1984 RCRA Amendments is both new and voluntary. It is hardly surprising that companies concentrate their efforts on avoiding penalties and installing proven and accepted methods of environmental protection rather than investing resources in voluntary programs they know little about.

Second, the current waste minimizaton program under the 1984 RCRA Amendments is not designed to give companies strong incentives to promote waste reduction. As discussed elsewhere, the language of the national policy statement in the amendments makes clear the primacy of waste reduction but subsequent sections of the statute give equal attention to good waste management. In the regulations promulgated under the amendments, the concept of waste reduction as defined in this study and in the national policy statement has all but disappeared. Under the regulations, waste minimization appears to mean any measure that avoids landfilling hazardous materials. People in industry are, not surprisingly, reacting to the regulations rather than the policy statement and have adopted this latter interpretation of waste minimization as the basis for their efforts.

The extent to which this program will prompt extensive action in large corporations is not yet clear. Preliminary signs suggest that the amendments are affecting corporate thinking—that they are bringing waste minimization and better waste *management*, if not waste reduction,[17] to the attention of corporate decisionmakers in an unprecedented way. The amendments have also provided environmental engineers with a justification for implementing waste reduction measures or, at least, collecting waste reduction information. On the other hand, it is clear that these voluntary efforts under RCRA will focus on minimization of RCRA wastes; they are unlikely to aim at multimedia waste reduction. How significant or far-reaching these voluntary actions will be is unclear and is likely to remain so since, as discussed elsewhere in this report, no meaningful data are being collected on current waste reduction efforts.

HOW MUCH WASTE REDUCTION IS POSSIBLE?

Why People Ask This Question

In view of the very large number of targets for waste reduction, the many ways to achieve it, and the lack of data, it is impossible to forecast future levels of waste reduction even approximately. Nevertheless, from a public policy perspective it would be useful to get a handle on the upper technical bound for waste reduction. No matter how much waste reduction may already have been accomplished, unless the potential amount is known, there is always uncertainty and even suspicion about the significance of the effort. That is, the degree of unrealized waste reduction potential is seen as the definition of the problem; the higher the potential, the stronger the case for doing something (e.g., government setting new policy or industry spending more money). Although this might make some sense on environmental grounds, effective waste treatment is also an option and it may not always make sense to reduce wastes at a specific site. A point of diminishing returns is possible for waste reduction.

For example, when the polymer polyethylene was first manufactured in the early 1940s the amount of waste was 80 to 90 percent of the original raw materials. The waste is now less than 5 percent. But this does not necessarily say anything about how much of the current waste might be reduced nor whether its chemical nature, amount generated, and the way it is managed or released at specific sites results in environmental risks that might be reduced or avoided. Further waste reduction may or may not make environmental or economic sense, but that cannot be known unless the possibility of waste reduction is seriously examined.

Why Forecasts Are Uncertain

Even if general economic factors are excluded, estimates for technically and economically feasible amounts of waste avoidance and reduction in the future are uncertain because:

- There are too many industrial processes and wastes—certainly tens of thousands—to examine each in detail.[18]
- Waste generation and reduction are plant- and process-specific, but the limited waste generation data available are aggregated over many processes and usually over a diversity of plants and companies.
- It is not known how much waste in all (*not* just RCRA waste) was and is now being

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[17] See chs. 1 and 5 for discussions of the differences between waste minimization and waste reduction and why they are important to OTA's study.

[18] Chemical Waste Management, Inc., has identified nearly 100,000 different wastes in its waste management business.

generated; therefore, reduction cannot be documented.

- There is no base year for all data.
- It is difficult to predict what changes in production technology and products will occur over a broad range of industry for reasons unrelated to waste, and such changes can substantially change the nature or quantity of waste, or both.
- Considerable amounts of wastes (particularly as regulated under the Clean Water and Clean Air Acts) are legally sanctioned and continued implementation of environmental programs will create more waste (e.g., pretreatment standards under the Clean Water Act increase the generation of solid, hazardous wastes).
- Many regulatory, enforcement, and judicial actions that affect the economic feasibility of and perceived need for waste reduction may occur.

Limited Expertise Problem

There is always an important systematic error in any estimate of future waste reduction. Considering the range of technical approaches, the best any analyst will be able to do is to make estimates for the techniques that are easiest to use, such as in-process recycling. Much more difficulty will be encountered in estimating waste reduction for the other approaches. No person or group, either outside or inside a company, is likely to have detailed information about enough industrial technologies and processes to be able to estimate the results of all or most of the changes that may, to varying degrees, reduce waste. Consequently, estimates, even by those in industry responding to a survey or those studying the technical literature and making professional judgments, are likely to be on the low side and to vary greatly. In most estimates there is little information about the approaches to waste reduction that were considered and how they were applied to industry sectors or waste streams.[19]

Facility Siting Bias

Some States have made estimates of future waste reduction, often in association with attempts to site waste *management* facilities. Such estimates are made in the context of the current system; that is, a predominantly voluntary approach to waste reduction which is not being implemented as if it had primacy over pollution control. **In the context of siting, little attention has been given to the potential importance of waste reduction in: 1) reducing the need for more sites, and 2) assuring the public that everything has been done to reduce the number of sites that will be needed.** State agencies sponsoring these estimates often have a bias toward siting waste management facilities. Moreover, the forecasts are based on surveys of generators who send large amounts of waste offsite. Therefore, they are likely to err on the low side; that is, to underestimate the amount by which waste reduction may reduce the need for waste management facilities. Also, waste generators naturally want to keep waste management costs low, which can be accomplished in part by ensuring enough offsite capacity.

Diffusion of and Access to Waste Reduction Technology

Waste reduction in the future will be affected by the extent to which information and products are diffused throughout industry and are available to companies. For the most part, the country is in the early stages of transferring waste reduction technology. Indications of this process are:

- Companies that have been successful at waste reduction are making their knowledge and expertise available to other divisions and are sometimes profitably selling the technology to other companies.
- State programs generally focus on efforts at transferring information and providing

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[19] A good example of this problem is the information in U.S. Congress, Congressional Budget Office, *Hazardous Waste Management: Recent Changes and Policy Alternatives* (Washington, DC: U.S. Government Printing Office, May 1985). Information given on changes in waste generation due to waste reduction is misleading because limited information prevented the full range of techniques from being considered, although this was not very clearly stated. Thus, the total waste reduction amounts reported are systematically low.

technical assistance, particularly to smaller companies.

- There are increasing numbers of conferences, workshops, awards presentations, publications, and courses helping to spread information.
- More information is becoming available from other nations where there sometimes is a longer history of interest in low-waste or pollution-free technologies.
- Some companies in the waste management industry are beginning to develop commercial ways of developing, applying, and transferring waste reduction technology.
- Financing is becoming available for waste reduction activities, although financing is likely to remain a problem for many firms.

Under current Federal and State programs there will not be a very comprehensive or efficient transfer of technology and information in the near future. Because waste reduction technology is evolving from simpler to more complex and process-specific techniques, it will become more difficult to transfer. In-process recycling and plant operations add-on techniques, currently emphasized, are the easiest to transfer across companies and industries. One other type of waste reduction is also readily transferable; that is, the substitution of certain raw materials to common manufacturing operations. An example previously mentioned is the replacement of solvent-based inks with water-based ones; some printing plants have essentially eliminated their generation of spent solvents in this manner. Companies that manufacture products used by other companies as raw materials will increasingly commercialize new products with waste reduction advantages for sale to U.S. industry and in foreign markets.

Competition From Waste Management Alternatives

The degree to which waste technologies are implemented in the future will depend strongly on alternative waste management methods. Different approaches to waste reduction will, to some extent, compete with each other, and the competition between waste reduction and the more traditional waste management approach will persist. Current corporate efforts to market more effective waste management technologies and pollution control techniques and to site new waste management facilities are not necessarily consistent with fostering waste reduction at the source. Indeed, in the 1984 RCRA Amendments there is some conflict between the goal of waste minimization and that of waste reduction.

Waste minimization is generally taken to mean reducing the amount of waste that is land disposed (see ch. 5). Lack of data and imprecise forecasts contribute to the attitude that environmental protection means only *better waste management*. **Although it is better to treat wastes to render them permanently harmless than to use any form of land disposal, it is still better to avoid or reduce the generation of hazardous waste, if it is technically and economically feasible.** *Any* waste management activity will pose some environmental risks and require regulation. There is no fundamental reason to believe that waste *management*, which involves repeated spending, is always or even usually more economical than waste reduction, although it may be in some circumstances. It is because waste management has been inexpensive that there often has seemed to be little point in cutting costs by not generating wastes to begin with. For some time to come, waste reduction, particularly by more costly methods, will face competition from waste treatment and disposal technologies. (Most available data reveal no sign yet of a major decrease in the use of land disposal.) This may change, however, because of the closure of onsite waste management facilities which have not been able to comply with new RCRA requirements which have not been able to comply with new RCRA requirements, increased production levels, and uncertainties about how some of the 1984 amendments to RCRA—notably the land disposal bans—will be implemented.

Waste management will remain a viable alternative for the foreseeable future. Both government and industry will make many decisions affecting the competition between waste reduction and waste management, and these are nearly impossible to forecast.

Review of Current Forecasts

Table 3-4 summarizes information and comments about several State efforts to obtain information on waste generation and reduction. The following observations can be made about the State information:

- Except for a downturn in 1982 to 1983, probably due to the economy, aggregated State data now show a trend toward an increase in hazardous waste generation because of economic growth and other factors.
- States are preoccupied with the issue of siting hazardous waste management facilities for wastes shipped offsite.
- Analyses of waste reduction are usually done for offsite wastes. These are only about 10 percent of the Nation's total generation; they may, however, represent high-hazard wastes.
- Although it is difficult to compare State studies, estimates of waste reduction for several States using similar methods vary significantly (Missouri, 4 percent; New Jersey, 7 percent; New York, 16 percent; Pennsylvania, 23 to 27 percent; Minnesota, 47 percent).[20]
- No attention has been given to non-RCRA wastes.
- Estimates for increases in hazardous waste generation due to increased water pollution control are relatively low but are only for wastes shipped offsite. They may be misleading because most pretreatment will be done onsite by large waste generators.
- No data are given for past or future plant-specific waste reduction.

In a Congressional Budget Office (CBO) study the data given indicate a total of 18 percent RCRA hazardous waste reduction nationwide over the period 1983-90. However, most of this —12 percent—is accounted for by volume reduction by dewatering, a practice OTA considers not environmentally significant. The remainder is accounted for by material recovery, but much of this is probably offsite and not within OTA's definition for in-process recycling. The CBO study did not consider the full range of techniques because of a lack of information. This is an understandable limitation common to most analyses, but it is not always made clear. Thus, the total waste reduction amounts reported are systematically low with regard to the reduction of waste at the source.[21]

A survey of companies for the Tennessee Valley Authority in 1984 found that by the year 2000 total RCRA waste reduction could be 11 percent for wastes which could be incinerated and 33 percent for wastes normally deposited in landfills.[22] The study used 1984 as a base year and kept production levels constant; a very small sample of companies were surveyed.

Although for most cases it is, *in principle, impossible* to reach zero waste generation, in OTA's survey, which stressed technical feasibility and a broad definition for hazardous waste, 11 percent of the respondents felt that 50 to 75 percent reduction was possible through a variety of efforts; 25 percent of the respondents felt that 25 to 50 percent was possible, and 59 percent felt that less than 25 percent reduction was possible. But, again, such estimates may be low.

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[20] One possible explanation of this rather large range of estimates is that the types of industries vary greatly among these States, but other factors may also be important, such as varying definitions and varying perceptions by survey respondents of what is possible and what is *likely* in the near term.

[21] Congressional Budget Office, *Hazardous Waste Management: Recent Changes and Policy Alternatives*, op. cit. Another aspect of this study is that it is essentially an analysis based on modeling. Although the total amount of waste generation obtained is in agreement with other data sources, none of the other detailed data which deal with the distribution of waste generation among waste types, industries, management technologies, or States are in agreement with other data sources.

[22] Battelle Columbus Laboratories, "Report on Hazardous Waste Management Needs Assessment," June 1984.

Table 3-4.—State Information Related to Waste Reduction

ILLINOIS: The State Environmental Protection Agency collects data on generation of hazardous waste from all generators:

Millions of gallons		
1982	1983	1984
547.3	460.7	526.2

The agency does no analysis of these data for waste reduction.

SOURCE: Illinois Environmental Protection Agency, *Summary of Annual Reports on Hazardous Waste for 1982, 1983, 1984*, September 1985.

MICHIGAN: State Department of Natural Resources data on generation of RCRA hazardous waste:

1983 425,000 tons

The Department estimated 6 percent maximum increase in generation from 1980 to 1990 attributable to economic development. After other factors were considered (waste reduction *not* among them) it is said that a 10-percent increase compared to 1983 is reasonable for existing generators. Very little consideration of waste reduction.

SOURCE: Michigan Department of Natural Resources, *Hazardous Waste Management in Michigan*, March 1984.

MINNESOTA: The Waste Management Board has compiled data principally to aid in estimating the need for a hazardous waste disposal facility in the State. The Board's data on generation of industrial hazardous waste (RCRA waste only):

1984 123,000 tons

Of this total 31,000 tons is managed onsite. Estimates of waste generation in the years 1990 and 2000 are based on combined effects of economic growth and waste reduction efforts. Detailed economic growth rates for industry segments are given. Estimates of waste reduction for the year 1990 are based on 97 estimates of reduction by waste type and industry segment. From 1984 to 1990 waste generation is projected to increase to 153,000 tons because economic growth outweighs waste reduction (no waste reduction figure given). For the year 2000, a weighted average of percent reduction figures given for waste types (without industry segments) yields an estimate of 47 percent reduction relative to 1984. Waste generation in the year 2000 estimated to be 126,000 tons due to additive effects of slower economic growth and increased waste reduction. Only RCRA wastes considered. Analysis also given for reduction of waste treatment residuals.

SOURCE: Minnesota Waste Management Board, *Estimate For Need*, 1985.

MISSOURI: Study for the Environmental Improvement and Energy Resources Authority focused on the possibility of a State owned hazardous waste treatment and resource recovery facility. Generation data therefore includes only wastes shipped offsite:

1982	1983	1987	2002
57,000	56,000	61,000	85,000 tons

Projections for future years are based on economic growth, *source reduction*, and projected additional RCRA waste from pretreatment (10,000 tons in 1987 and 13,000 tons in 2002). Source reduction for 1987 is estimated at 4 percent (2,000 tons); no further reduction is projected thereafter (3,000 tons in 2002), even though it is stated that "much more waste reduction may occur by 2002." Estimates are based on reduction of eight wastes in seven industries.

SOURCE: Environmental Improvement and Energy Resources Authority, *Missouri Hazardous Waste Treatment and Resource Recovery Facility Feasibility*, January 1985.

NEW JERSEY: The Facilities Siting Plan focuses on siting commercial hazardous waste management facilities and, therefore, uses data on wastes shipped offsite (manifest data):

1981	1982	1983
412,000	344,000	403,000 tons

Projected waste reduction for 1988: 33,000 tons. This is relative to 460,000 tons used as a composite average for 1981-83 plus the effects of economic growth. The result is a waste reduction estimate of 7 percent over about a 6-year period, based on estimates for 30 industry-waste type possibilities (4 of which were increases). No similar analysis is given for waste generated and managed onsite (11,767,000 tons for 1983, based on 242 annual reports). Potential increase in hazardous waste due to new actions under Clean Water Act: 33,000 tons. No consideration of reduction of non-RCRA wastes.

SOURCES: New Jersey Facilities Siting Commission, *New Jersey Hazardous Waste Facilities Plan*, March 1985.

Table 3-4.—State Information Related to Waste Reduction—Continued

NEW YORK: The State Department of Environmental Conservation uses the following generation data on manifested, offsite RCRA wastes for siting purposes:

1982	1983
285,000	251,000 tons

Projections are made as follows for other years, based on consideration of many factors including economic growth and source reduction, but no details are given:

1984	1988	1994
280,000	308,000	365,000 tons

For one 1988 scenario involving high waste reduction, an additional degree of waste reduction (for RCRA wastes only) is specified above that presently planned by industry; reduction there is projected to be 48,400 tons, or 16 percent, of the 1988 base. This is based on estimates for 34 waste types (no industry segment breakdown), of which 24 had no change.

SOURCE: New York Department of Environmental Conservation, *New York State Hazardous Waste Facilities Needs Assessment*, March 1985.

NORTH CAROLINA: The Governor's Waste Management Board uses data for RCRA hazardous waste shipped offsite because of its interest in siting:

1981	1982	1983
48,650	42,800	52,550 tons

No analysis of data for waste reduction.

SOURCE: Governor's Waste Management Board, *Hazardous Waste in North Carolina*, undated.

PENNSYLVANIA: Data on waste generation compiled by the Department of Environmental Resources are used for siting and therefore focus only on manifested, offsite RCRA waste:

1981	1982	1983	1984
774,000†	485,000	598,000	639,000 tons

Projected waste reduction for 1990: 181,000 tons (expected case) and 211,000 tons (high *source reduction* scenario) relative to composite (1982-84) base of 661,000 tons, accounting for economic growth only. That is a reduction of 23 and 27 percent over about a 5-year period. These figures are based on estimates for 104 industry-waste type possibilities (16 of which had no change). Data may be misleading as *source reduction* may include actions that reduce waste shipped offsite, but still generated. For waste generated and managed onsite (4,200,000 tons for 1983), no similar analysis of reduction is given. Potential increase in amount of hazardous waste generated due to new actions under Clean Water Act estimated at 4,000 tons. No consideration of reduction of non-RCRA wastes.

†Calculated by OTA on basis of reported data.

SOURCE: Pennsylvania Department of Environmental Resources, *Pennsylvania Hazardous Waste Facilities Plan*, draft, November 1985.

WISCONSIN: Department of Natural Resources RCRA hazardous waste generation data:

1979	1984
300,000 to 500,000	125,000 tons

Change attributed to waste reduction without detailed analysis of other factors. Goal of 100 percent reduction and recovery for 8,000 tons land filled in Wisconsin (another 26,000 tons landfilled in other States) in 1984, but now Wisconsin has no landfill capacity for hazardous waste.

SOURCE: Wisconsin Department of Natural Resources, *Wisconsin Waste Reduction and Recovery Plan*, August 1985.

CONCLUSIONS

There are technical reasons for concluding that it is not possible to accurately estimate future waste reduction in terms of the maximum technologically possible. Indeed, the technical possibilities for waste reduction are rapidly changing. Moreover, estimates are likely to be low. People outside of industry are not likely to be sufficiently familiar with industrial operations to make good forecasts. People in industry are unlikely to be able to assess the full range of waste reduction techniques possible—and not merely likely—in the near term *and* long run.

The technological potential for waste reduction is substantial, although it is quantifiable only in the most approximate terms, across both industries and waste types. **The conclusion that there are many opportunities for waste reduction in the future rest on evidence that industry has not yet been sufficiently motivated, has not had enough time to do more than get started, and has only begun to exploit the possibilities technology offers.**

It might be more useful to *focus on a waste reduction goal rather than to try to calculate how much is possible.* For example, a goal of perhaps 10 percent annually might do much to stimulate and draw more national attention to waste reduction. This goal is consistent with results obtained so far and with goals used by some companies. If waste reduction is to offset increases in waste generation from economic growth and increases from more wastes becoming regulated under pollution control programs, then such a goal may be needed just to hold the line on requirements for hazardous waste management.

Chapter 4

Data and Information for Waste Reduction

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Chapter 4

Data and Information for Waste Reduction

INTRODUCTION

One of the great obstacles to waste reduction policy analysis is scarcity of information.[1] In developing waste reduction policy, Congress and government agencies should have data from many industries on current waste generation, waste reduction accomplished so far, and estimates of possible future waste reduction. Such data would help Congress and the agencies to decide if action is needed, what kinds of actions might be taken, and what kinds of wastes or which industries might be targeted for action. Few of these data exist and those that do, for example waste generation data, are collected in such a way that they reveal little or nothing about waste reduction.

Current waste generation data are inadequate for several reasons. First, the vast majority of waste generation estimates are for only wastes regulated by the Resource Conservation and Recovery Act (RCRA). They do not include emissions into other media; neither do they include releases of nonregulated hazardous wastes.[2] Second, annual waste generation estimates for the Nation vary widely and must be viewed as highly uncertain because they are based on sampling and modeling. Third, virtually all existing estimates of waste generation are estimates of mass, weight or volume only; no attempt is made to estimate the degree of hazard of the waste.

Simply knowing that a company has reduced the volume or mass of its wastes tells nothing about true waste reduction because no information is given about the hazardous content of the wastes before and after. Many hazardous waste streams are made up principally of nonhazardous substances (often water) and contain only a small amount of hazardous material. Even RCRA sludges frequently contain a substantial amount of water and other nonhazardous materials. Simple dewatering of wastes can produce large volume decreases with no actual decrease in the waste's hazardous substance content.

Finally, waste generation figures are in no way correlated to production. Many companies and some entire industrial sectors recorded less waste generation in the early 1980s than in previous years, but industrial production was down during that period. It is impossible to tell how much reduction in waste generation occurred because of reduced production and how much resulted from implementation of actual waste-reducing measures.

Thus, **generation data as they are now collected are not useful for assessing either potential or achieved waste reduction.** End-of-pipe generation data do not reveal enough about what is going on inside the plant to allow anyone to differentiate between changes due to waste reduction and those that are caused by changes in production levels, product mix, or even waste treatment methods, all of which may affect the composition and mass of a company's total waste stream.

The crux of this problem is that planning and assessing waste reduction requires fundamentally different sorts of data and information than have been required for traditional pollution control environmental progams. As was discussed in chapter 3, waste reduction is a form of production process or operations improvement. It requires actions at the front end of the process, rather than at the end of the pipe where current pollution control programs focus. *Planning, implementing, and assessing waste reduction are activities that require the same kinds of production information that would be required for any other production improvement. They also require data about the amount of hazardous waste generated per unit of production output, as well as data on costs and savings of the waste reduction actions.*

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[1] In this chapter the term "data" is used to denote numerical measures of or facts about waste reduction. The word "information" is used to indicate a broader set of facts about waste reduction, including those that are numerical and those that are nonnumerical. Thus, data are a subset of information here.

[2] OTA's own estimate is that between 255 and 275 million metric tonnes of *RCRA* hazardous wastes are generated each year, but this figure does not even attempt to account for wastes generated under the Clean Air and Clean Water Acts, nor does it include nonregulated hazardous wastes. [U.S. Congress, Office of Technology Assessment, *Technologies and Management Strategies for Hazardous Waste Control*, OTA-M-196 (Washington, DC: U.S. Government Printing Office, March 1983) p. 3.] OTA's forthcoming report, *Wastes in Marine Environments*, will examine data on quantities of wastes regulated under the Clean Water Ac

Companies often do collect this type of information when reducing their waste. However, as this chapter makes clear, this is not the type of information currently being collected by government, a fact which has important implications for the development of waste reduction policy (see ch. 2).

INDUSTRY INFORMATION NEEDS

Almost all information relevant to waste reduction *must* come from industry. Government can affect the kinds of information industry collects through new regulation, and it can also affect the format of collection (specifying periodicity of data, for example), but the fact remains that information must be collected by industry.

Information Needed for a Waste Reduction Audit

A waste reduction audit can provide the information a company needs to reduce its wastes. Many companies do not conduct formal audits prior to instituting waste reduction measures. Waste reduction largely remains a byproduct of other process improvements or is undertaken on an ad hoc basis to address one waste that presents immediate problems or costs. However, as the concept of comprehensive and systematic waste reduction becomes better understood and more effectively implemented, audits will become more common because they provide analytic support for waste reduction decisions. Even when taking ad hoc actions, however, companies usually try to pull together *some* of the information and data discussed below that make it possible to plan and carry out waste reduction in an effective manner (see table 4-1).

Chapter 3 discusses the steps that a company might go through in conducting a waste reduction audit. Following is a description of information generated by each step of the audit.

Step 1: Identification of Hazardous Substances of Concern in Wastes or Emissions

Companies must identify the *amounts* and *kinds* of hazardous wastes they generate before they can do anything about reducing them. This analysis can be done at radically different levels of detail and the level of detail of the information required will vary accordingly.

Companies may choose to or may have to make only rough estimates of the kinds and amounts of wastes generated. If only a limited level of waste reduction effort is planned or is possible, this gross analysis may be sufficient.

Better data on the chemical composition and quantities of wastes can be generated, at greater expense, by systematically conducting chemical analyses of the company's waste streams *over time* (an especially important factor in conducting analyses of batch processes where waste streams are not constant). This method of waste identification is now common in industry since many companies already collect chemical analysis data on wastes to help them with plans for waste management. However, the drawback to this method is that companies are unlikely in practice to be able to identify *all* waste streams that must be analyzed, including fugitive emissions, leaks, and spills.

Table 4-1.—Industry Information Needs for Waste Reduction

Waste reduction action	Type of information needed
Identify hazardous substances of concern in wastes or emissions	Kinds of hazardous wastes generated **[Type W]** Amounts of those wastes generated **[Type W]**
Identify source(s) of the hazardous substance(s) of concern	Above, plus process engineering and chemistry **[Type T]**
Set priorities for actions	Above, plus any regulation affecting wastes generated **[Type R]** Health effects and degree of hazard posed by different wastes **[Type H]** Ease and expense of implementing waste reduction for any substance (see below)
Analyze and select technically and economically feasible reduction techniques	Above, but more specific process engineering and chemistry information **[Type T]** Potential costs/savings of the waste reduction action **[Type E]** General economic situation of the company **[Type E]** Market information about the affected product(s) and estimates of any effects waste reduction may have on the product **[Type E]**
Compare economics of waste reduction with waste management alternatives	Above, plus current waste management costs including potential liabilities **[Type E]**
Evaluate waste reduction progress and success	Above, plus waste stream contents **[Type W]** Actual waste reduction costs/savings **[Type E]** Glitches, inconveniences, and unforeseen benefits to waste reduction activities **[Type T]**

KEY: Type W = Waste stream data.
Type P = Production information.
Type E = Economic information.
Type T = Technology information.
Type R = Regulatory information.
Type H = Health and environmental effects information.

SOURCE: Office of Technology Assessment, 1986.

The most complete and reliable measure of the quantities of specific substances released into the environment is obtained from mass balance calculations. By subtracting the amount of a hazardous substance going out as product (if any) from the amount brought into the plant or process, a company can calculate the total amount that appears as waste and can then attempt to account for this amount through waste stream measurements. Such calculations may contain major uncertainties,[3] and accounting for all of a substance in a process is usually time-consuming and expensive. Mass balance calculations are done routinely in some industries, but frequently they are not sufficiently sensitive for waste reduction purposes.[4]

Step 2: Identification of the Source(s) of the Hazardous Substance(s) of Concern

Without knowing exactly which processes are generating which wastes, a company cannot know how to reduce those wastes. Information at this stage may also be collected at varying levels of detail. Companies can informally link their identified wastes with the process(es) or operation(s) already known to produce them without collecting additional information, or they may attempt to trace hazardous substances back to where waste generation is occurring. One effective way to do this is to conduct process level mass balance calculations for hazardous substances and then search processes for points of waste generation or emission until all waste has been accounted for.

Tracing every hazardous substance back through the process and accounting for all wastes and emissions is an overwhelmingly ambitious task. Companies usually attempt to identify waste sources for only some of their wastes.

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[3] Uncertainties in mass balance calculations due to chemical changes within process and to measurement errors are discussed later in the chapter (see discussion accompanying figure 4-1 and discussion of screening for degree of hazard and chemical change).

[4] The USS Chemicals example noted in the waste reduction audit discussion in ch. 3 shows how significant amounts of waste may fail to be detected by mass balance calculations in a very large operation.

Since they have limited resources, companies may reasonably decide that they can identify enough waste reduction opportunities without seeking complete, detailed information about all their wastes and waste sources.

Step 3: Setting Priorities for Waste Reduction Actions

Priorities for waste reduction actions may be influenced by:

- existing regulations affecting particular types of hazardous wastes,
- the need to conserve costly raw materials,
- the ease and expense of implementing waste reduction for particular substances (see Step 4, below), and
- the adverse health effects and degree of hazard of different wastes.

In some cases, one of these factors may override all others. For example, regulations may promote some waste reduction action for a particular substance, in which case information on the others may be of academic interest only.

Step 4: Analysis and Selection of Technically and Economically Feasible Reduction Techniques

Having decided which wastes to target, a company must then decide on the best way to accomplish reduction. Required at this stage is information about process engineering and materials, the costs of waste reduction approaches and the savings possible from their use, the risks involved in making changes, and internal investment conditions.

Process engineering and materials information for the target processes is most often provided by in-house personnel but, in some instances, waste reduction information from outside—from other plants, trade associations or State technical assistance programs—may be useful. OTA has found that transfer of waste reduction technology through information provided in publications—as is commonly attempted now—is, or is perceived to be, an unsuccessful method by most companies. A company may be able to adopt a general idea from waste reduction literature but substantial tailoring to onsite conditions must follow in most cases. Direct technical assistance, in the form of a consultant brought onsite, may be more useful (although consultants are often not knowledgeable about a specific plant's operations), but is also more expensive. Offers of such assistance by government may be resisted because of proprietary concerns.

Cost and savings information on waste reduction approaches includes their anticipated effects on the costs of capital, labor, raw materials, and waste management. Potential side effects on production operations and product quality may also be important and must be assessed. Tight estimates of these figures are difficult to make because waste reducing measures are front-end process and operations modifications and may have effects on other parts of the process or operation that are difficult to predict.

Information needed about risks involved in waste reduction actions include the cost of disrupting operations and possible costs associated with changes in product quality.

Step 5: Economic Comparison of Waste Reduction Alternatives With Waste Management Options

Waste reduction opportunities must be shown to be economically preferable to more traditional pollution control methods if they are to be judged attractive. Information that will be required to compare waste reduction measures with the alternative of waste management includes data about the technical and economic characteristics of the waste reduction action (discussed in Step 4) as well as information about current waste management costs.

The economic assessment of waste reduction versus management must include some information, however fuzzy, about the potentially enormous costs associated with waste management liability. Quantifying these risks or costs is difficult, but even if the risk of becoming involved in a Superfund site is small, the potential costs are so large that for many companies this becomes the primary motivation for waste reduction.[5]

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[5] See the results of OTA's industry survey in app. A.

Step 6: Evaluation of the Progress and Success of Waste Reduction Measures

In order to plan future waste reduction intelligently, companies must find out how successful their past and current efforts are. They must know how waste reduction measures have altered the composition and amount of their wastes and what the costs and savings have been. They must also compare actual costs and savings with the estimates that were made in the planning stage to understand how good their planning has been.

Information needed for this step includes:

- enough information on all postreduction waste streams, including their composition, amounts, and fate, to measure reduction and to show to what extent wastes have just been shifted from one environmental medium to another;
- waste reduction costs and savings, including information about unanticipated glitches, inconveniences suffered, and any unforeseen benefits of waste reduction; and
- Step 4 and 5 planning information for comparison with results so that the company can ascertain how good its planning estimates have been.

Charging Full Waste Costs to Processes

To reduce their waste generation, companies need to be able to factor waste-related data into decisions made about actions that will take place at the front end of production. This can be done most effectively by charging each production process with the ultimate costs (including possible liabilities) of managing the wastes it generates. This seems obvious but it is frequently not done, and this neglect exerts a bias against waste reduction. Waste management costs, such as the costs of running a company's onsite treatment, storage, and disposal facility (TSDF), may be a separate budget item. When management costs are externalized in this way, design engineers, plant managers, and processes engineers have little incentive to reduce wastes. Production decisions may be made in favor of more waste-intensive methods *which are not cost-effective* because waste management costs have not been fully factored into the decision. Only when companies develop accounting information on waste costs at the process and operations level can cost-effective decisions and the full economic benefits of waste reduction be demonstrated.

TYPES OF WASTE REDUCTION INFORMATION

We have seen that each company or plant operation requires many different kinds of information if it is going to be effective in reducing the generation of waste. Government and the public, too, will need many types of information to understand how waste reduction is proceeding. OTA has grouped the information discussed above into six types based on its character and source. They are:

1. **Type W**: *Waste stream data.* These data identify the chemical composition of a waste stream and the amount of each hazardous substance present and relate chemical contents to different processes and points within processes.
2. **Type P**: *Production information* on types and amounts of inputs (raw materials) and outputs (product) measured over time and proportions of inputs which end up as hazardous wastes or react to produce hazardous wastes.
3. **Type E**: *Economic information* including: 1) costs and savings of waste reduction measures; 2) waste management costs, including liability costs; and 3) information on the general economic situation of the company (e.g., available capital, labor costs, production costs).
4. **Type T**: *Technology information* on the chemistry and engineering of company

processes and on possible waste-reducing changes to those processes.

5. **Type R**: *Regulatory requirements* that affect the company's operations or that affect proposed waste-reducing changes in those operations.
6. **Type H**: *Health and environmental effects and degree of hazard information* on hazardous substances. Also included is information about degree of risk, which may comprise a wide range of data about concentrations of substances, disposal methods, and the environmental characteristics of the areas in which wastes are generated, handled, transported, and disposed.

Several characteristics of these information types are particularly critical for formulating policy. First, only the last two, regulation information and health/hazard information **[Types R and H]**, are uniform throughout industry. There is a set of standard government regulations (State and Federal) under which all companies operate. Similarly, standard data on the health effects of different hazardous substances could be compiled.[6] Technology information **[Type T]** may be generic to some extent, but less so than it is for pollution control programs. For pollution control and management programs (RCRA, Clean Water, Clean Air, Superfund) a discrete set of compliance or cleanup technologies can be identified which can be applied to waste streams. Pollution prevention process improvements can be categorized and common techniques identified, but, as chapter 3 shows, it is not possible to compile a list of technologies for waste reduction. Economic, production, and waste stream data **[Types E, P and W]** are clearly specific to operations.

Second, the kinds of information which weigh most heavily in industry decisions about waste reduction tend to be those that are operation-specific, i.e., economic, production, and waste data. Health and degree of hazard information **[Type H]** are usually less important in industry's decisions about waste reduction; regulatory information **[Type R]**, on waste reduction, is currently quite limited.[7]

Information that most directly affects industrial waste reduction efforts, particularly economic information about production, waste management costs, and liabilities, is diffuse, specific, and often confidential. As discussed below, this has important implications for government policy.

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[6] Degree of risk calculations would have to be more site-specific because these vary with population density, exposure rates and other site-specific data.

[7] Ch. 5 discusses the *voluntary* nature of the current Federal waste minimization program.

INFORMATION NEEDED FOR FEDERAL POLICYMAKING

Industry and government collect different types of information because they play different roles in waste reduction. Industry collects detailed process improvement information for direct application to a specific waste generating processes. The Federal Government, on the other hand, needs to know the sum of all or a great many individual waste reduction actions, whether they represent successes or failures, and how this information relates to larger U.S. industrial, economic, and environmental issues and policies.

All Federal action options require a baseline of information that will yield answers to questions about this big picture. An overall view is required to assess the nature and scope of waste reduction possibilities, to set priorities, and to help determine what kind of Federal action will best serve the public good. In the case of waste reduction, some important questions are:

- How much hazardous waste of all kinds, released into all environmental media, generated in the United States each year?

- How much is that generation figure changing each year?
- To what extent are the changes a reflection of industrial production and to what extent are they the result of waste practices?
- How much waste reduction is possible? When could it be achieved?
- How much do different increments of waste reduction cost? What are the risks? What are the benefits?

To answer such questions and to paint a big picture of the waste reduction issue, detailed information is needed on many small waste reduction pictures around the country. Doing this without becoming swamped in masses of data is not simple, either in theory or in practice. In order to make sense of masses of waste reduction data, government will need:

- waste reduction information from a significant number of representative generators in a representative cross-section of industrial sectors, company sizes, and geographic locations;
- data standardized in format, collection procedures, and periodicity; and
- a data management system to allow analysis of data once collected.

Existing data systems do not come close to satisfying any of these criteria. Neither do they shed much light on any of the basic questions about the waste reduction situation. Part of the reason for this lies in the way in which we currently collect information about hazardous wastes, but the complexity of gathering waste reduction information itself is also responsible.

Waste Reduction Information Available to Government

Sources of information about hazardous substances in the public domain and comments on their usefulness for waste reduction are briefly cataloged in table 4-2. The Federal programs under which these data are collected are discussed in chapter 5.

Usefulness of Current Data for Waste Reduction

Data currently being developed and maintained by the Federal Government for pollution control do not provide any basis for a hazardous waste reduction program. This mass of information provides few insights into current waste reduction rates and no sense of how much waste reduction might be possible in the future. Inadequacies of these data for waste reduction stem from the fact that existing pollution control programs are: not multimedia in nature, address only a limited number of hazardous substances, and address a different set of substances in each environmental medium. The data collected, especially under RCRA, are not usually substance-specific but cover some conglomerate waste, only a portion of which is hazardous.

In addition, the following features combine to seriously limit the applicability of these data to waste reduction analyses:

- While a large amount of data is available on wastes, very little is available on the processes that generate the wastes. This is not surprising given the pollution control orientation of current regulations.
- What little production and process information exists is protected as confidential business information (CBI) which limits access to this data by the public and also by the staff of the Environmental Protection Agency for any purpose other than that for which it was explicitly collected. Much of this data was not available to the waste minimization people within EPA.
- There is little uniformity in collection method or time period in the existing data. Much of the most useful data for waste reduction has been collected only on an ad hoc basis, often as part of a contractor's study to support action on some single substance or small group of substances. Much of the national data is extrapolated from a sampling of representative plants. Samples

Table 4-2.—Existing Sources of Information Collected by the Federal Government and Their Applicability to Waste Reduction

Sources of potentially useful information	Limitations on applicability to waste reduction
RCRA:	
General	1. RCRA-defined waste categories for information collection are very broad and often contain large amounts of nonhazardous constituents. 2. RCRA-regulated wastes are only a fraction of total wastes generated in the United States.[a]
Manifest information including quantities and types of wastes shipped offsite [Type W]	1. Data not centrally collected or managed. Manifests are dispersed throughout State and EPA regional offices. Data not completely or centrally computerized; often hard copy only. 2. Waste type identification is not always accurate. 3. No data about waste minimization program is contained in certification 4. Manifested wastes are only a small percentage of total wastes generated in the United States.
Biennial report information (summaries of generator and TSDF activities submitted every 2 years; includes description of waste minimization activities and program) [Type W, perhaps some of types T&P]	1. States administer biennial reporting and use different definitions, making it impossible to combine data from different States. 2. Descriptions of waste minimization activities included are in a narrative form and quantitative data on waste minimization activities or achievements not standardized. 3. Waste minimization information only required of generators who ship offsite. 4. Waste minimization not defined; can include a wide variety of recycling and other waste management activities in addition to waste reduction.
Hazardous waste permits for TSDFs including amount and type of waste to be handled [Type W]	1. Broadness of RCRA waste categories and inclusion of nonhazardous constituents. 2. RCRA-regulated wastes are only a small fraction of total wastes generated in the United States. 3. Permit waste figures are only one-time estimates; no time-series data to indicate changes/trends. 4. Waste minimization information retained on site of facility.
EPA's Waste Minimization Report [Types W, T, P, R, perhaps H & E]	1. Examines only RCRA-regulated wastes.[a]
Westat Survey (attempt to estimate national waste generation) [Type W]	1. Estimates only RCRA waste generation.[a] 2. Estimates RCRA generation only by waste *group* (F,K,U, etc.), not by waste stream (F001, F002, etc.). 3. There are quality problems with the data, stemming in part from the sampling method used. 4. Survey provides no time-series data; no waste reduction trends can be assessed.
Industry studies [Types W,P,T, perhaps E]	1. Completed only for two industrial sectors; underway for only two more. 2. Data collected only at only point in time; no trend data developed. 3. Data are confidential.
Clean Water Act:	
NPDES permit and monitoring information including amount and contents of discharges as well as process creating toxic pollutants [Types W,P]	1. Data are largely in hardcopy, not computerized, and therefore not easily accessible. 2. Most data are kept in regional offices, not easily accessible for national analysis. 3. Data are collected in all States only for conventional pollutants and the 65 CWA-listed toxic pollutants.[a] 4. Data only on permitted discharges, not on actual generation. 5. Data from technology-based standards will not be substance-specific. 6. Data reveal nothing about amount of pollutants shifted into landfilled sludge to achieve compliance.
Indirect discharge (pretreatment) data	1. Not centralized. Each indirect discharger and POTW keeps own data according to its own format.
Information used to set effluent guideline limitations, pretreatment standards, and water quality standards [Type W, some T,E,P]	1. Data developed with diverse collection methodologies by different contractors. 2. Data collected over differing periods of time. 3. Data collected only on a limited number of substances.
Clean Air Act:	
NESHAP standard-setting information [Type W, some T&E]	1. Exists only for a very limited number of substances.[a] 2. Data are mostly confidential. 3. Format, collection methods, period of collection of data vary widely.
NESHAP implementation data including emissions amounts and sources [Type W]	1. One-time only data; no time-series data, so no reduction trends. 2. Available on only a small number of substances (six).[a]
Information collected for the Ambient Air Quality program [Type W]	1. Not centrally managed; kept at the State level.

Table 4-2.—Existing Sources of Information Collected by the Federal Government and Their Applicability to Waste Reduction—Continued

Sources of potentially useful information	Limitations on applicability to waste reduction
Toxic Substances Control Act (TSCA):	
Inventory of 64,000 chemicals including amount produced by individual plants [Type P]	1. Collected only once for any substance. Much of it out of date. 2. Most of the data are confidential.
Exposure information for 250 chemicals—essentially plant-specific mass balance information [Types H,P]	1. Kinds of chemicals studied are not primarily chemicals of common concern in hazardous wastes. 2. Virtually all data are confidential.
Health and safety data [Type H]	1. Many of the raw test data have not been evaluated. 2. Substances are chosen for review because of their use in products in commerce and manufacturing, not because of their presence as pollutants.
Information on new toxic chemicals including process information and estimates of environmental releases. Data on 6,000 new chemicals received [Types W,P,T]	1. One-time only data; estimates of releases are not subsequently confirmed. 2. Virtually all these data are confidential.
Census Bureau, Department of Commerce:	
Production information for all manufacturing operations [Type P]	1. Census Bureau is legally barred from disseminating this information except on an aggregated, industrywide basis.
Bureau of Mines, Department of the Interior:	
Production and use information on hazardous minerals (e.g., mercury, cadmium)	1. Data available on only a small number of substances (minerals rather than chemicals).[a] 2. Information confidential except in aggregated form.
Consumer Product Safety Commission:	
Rough percentage data on hazardous constituents in various consumer products [Type P&H]	1. Data are old (1974). 2. No estimates on total production are provided.
Occupational Safety and Health Administration:	
Requires Material Safety Data Sheets listing hazardous constituents in chemicals sold [Type P]	1. No centralized database of this information. 2. Confidentiality can restrict information provided.

[a] Data collected under individual programs can rarely be combined for one purpose because of different collection methods used.

KEY: Type W = Waste stream data.
Type P = Production information.
Type E = Economic information.
Type T = Technology information.
Type R = Regulatory information.
Type H = Health and environmental effects information.

SOURCE: Office of Technology Assessment, 1986.

and techniques are not the same among industry categories and among programs within EPA and are not the same over time.

- Most information concerns emissions that are dispersed into only one environmental medium.
- Very different amounts, kinds, and qualities of data have been collected for different hazardous substances depending on the kinds of regulatory actions that have been applied.
- Very little, if any, information exists for the many hazardous substances that are not regulated.
- Existing data are not very accessible. Most often they are in hard copy and very often are scattered through regional and State offices throughout the United States.

Federal Authority To Collect More Information

Congress has recognized the need to collect information on hazardous substances. Considerable authority already exists under the Toxic Substances Control Act (TSCA) to collect information relevant to waste reduction should the Federal Government decide to pursue such an option. In addition, Congress has under consideration an expanded information-gathering program in the Comprehensive Environmental Response, Compensation, and Liabilities Act (CERCLA or Superfund) conference committee bill. If taxing provisions for Superfund are agreed to by the conference committee and both houses pass the full Superfund legislation, the government may have this new authority by the end of 1986.

Toxic Substances Control Act

Because TSCA is not a pollution control statute but is aimed at control of production and distribution of toxic substances, it may be more relevant to waste reduction than any other statute. There are, however, several major problems with attempting to use TSCA for waste reduction purposes.

To support the ranking of chemicals for investigation and chemical risk assessments required under TSCA, the act's Section 8 gives the Federal Government broad powers to obtain information on the production, distribution, and use of toxic substances. This authority has been exercised with the promulgation of the Preliminary Assessment Information Rule (PAIR) which required plant-level mass balance and exposure information on 350 chemicals as of December 2, 1985.[8]

There are, however, a few limitations on TSCA reporting authorities which might reduce the ability to use Section 8 to obtain information for a hazardous waste reduction program, especially to gather mass balance data. First, Section 8 reporting authorities extend only to existing and "reasonably ascertainable" information. Reporting of hazardous waste reduction information that has not already been collected by a company and that is not "reasonably ascertainable" cannot be required under Section 8. However, the more cumbersome rulemaking procedures of TSCA Section 4, which provide EPA with authority to require chemical testing, could be used to require the gathering and submission of previously unavailable information.

Second, because TSCA applies only to "chemical substances and mixtures," it may be difficult to obtain information about operations that assemble or fabricate articles. In the case of the PAIR described above, reporting is required only for manufacturers of the designated chemicals. Thus, those using the designated chemicals to make other products and those generating the designated chemicals solely as wastes have been exempted from coverage.

Third, there is a small business exemption provision incorporated into Section 8. Thus, information collected under this section does not cover all plants. For example, in the case of the PAIR, most manufacturers or processors with total sales of less than $30 million per year or with total annual production of under 100,000 pounds of a chemical have been exempted from reporting.[9]

Finally, because much of the information submitted under TSCA is production, rather than waste, information, it is claimed as confidential business information. CBI cannot be shared with State governments, hence any information collected under TSCA Section 8 would not be adequate to support a hazardous waste reduction program that involved any significant State implementation, as do current pollution control programs.

Superfund Reauthorization[10]

Both the House and Senate bills to reauthorize Superfund proposed a new hazardous substances national inventory reporting system. A comparative summary of these provisions is given in table 4-3.

The Senate version was very similar to the New Jersey Industrial Chemical Survey (see discussion below). The Senate bill required certain firms to report to EPA and State governments every 3 years through 1993 (three reports in all) on a list of chemicals prepared by EPA or the hazardous substances listed in CERCLA. The information to be reported included plant-level raw material, product, and emissions data.

The House version was aimed at making information available to communities to support emergency response needs. It provided for annual reporting by companies using, producing,

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[8] As proposed in February 1980, PAIR would have information on 2,226 chemicals. This number was reduced to 250 under the final rule issued in July 1982, in order to reduce the burden of reporting. Subsequent amendments to PAIR have raised the number to 350. According to the chief of the OTS Chemical Screening Branch, this reduction has limited the usefulness of the data. As it stands, PAIR provides data on too small a number of chemicals to allow ranking for Section 4 investigation, which was the purpose of collecting the data in the first place. [U.S. Congress, General Accounting Office, *CHEMICAL DATA: EPA's Data Collection Practices and Procedures on Chemicals*, RCED-86-63 (Gaithersburg, MD: February 1986), pp. 25-26.]

[9] Most chemicals produced in quantities greater than 100,000 pounds annually are made in continuous process operations. Batch process operations, which tend to be much more waste-intensive per pound of production than are continuous process operations, are therefore disproportionately excluded from reporting.

[10] As this report was going to press, Congress had finished its conference committee deliberations on new Superfund legislation. Complete details of the final bill, however, were not available in time to include them here.

Table 4-3.—Comparison of Proposed National Inventory Requirements in Superfund Reauthorization Legislation[a]

	Senate Bill	House Bill
Who must report	Manufacturers, processors (>200,000 lb/yr), users (>2,000 lb/yr) of listed substances; SICs 20 through 39	Companies producing, using, or storing listed substances
Hazardous substances list	EPA to prepare list following guidelines in bill; otherwise Superfund hazardous substances list effective	EPA's July 1985 Acute Hazards List or EPA determined list of those substances causing "imminent or substantial endangerment"
Reports due	1987, 1990, and 1993 only	Every year
Report content	Uses of chemical; estimated amounts	Chemical name (unless confidential)
Input data	Amount shipped to plant; amount consumed onsite	Amount present at plant
Output data	Amount leaving as product; amount shipped as waste/byproduct	Total annual amount released to environment and amount in excess of that permitted under Federal pollution control laws
Discharge data	Amount of discharges to air, surface water, land, subsurface injection, POTWs, and amount discharged from onsite treatment facilities (and treatment method)	Discharges to any environmental medium in excess of a designated amount
Submitted to	State office designated by Governor and to EPA	Local emergency response committee
Other comments	EPA required to computerize information received; information to be publicly available	Health data (MSD sheets) also must be reported with above information

[a] According to limited details available before this OTA report went to press, *both* the Senate and House reporting systems are included in the Superfund conference bill; some aspects have been changed.

SOURCE: Office of Technology Assessment, 1986.

or storing listed substances to local emergency response committees. The data required included an inventory of the amount present at a plant site, annual environmental emissions, and material safety information on each chemical reported.

According to some information available on the conference committee bill, Congress has decided to require both types of reporting. The more extensive Senate version ("toxic chemical release forms") will not start until 1988 and will be an annual report until 1993. EPA then has the discretion to lessen the frequency of the reporting cycle. The threshold amounts that determine who must report were lowered for manufacturers and processors but substantially increased for users. Under the emergency response inventory, EPA has been given the discretion to set thresholds and the information submitted may be aggregated into health and physical hazard categories. Congress has retained the requirement that EPA set up a computerized database for management of the data collected on the toxic chemical release forms.

Later in this chapter is a discussion about appropriate ways to measure waste reduction. As that discussion shows, the above national inventory systems fall short of providing definitive waste reduction data (see also ch. 2). They could, however, supply some preliminary information that may be helpful for initial policy decisions and setting program priorities. The establishment of such systems could also pave the way for more appropriate waste reduction data collection.

State Chemical Inventories

Some States have already conducted plant-level chemical inventories; none have been conducted for waste reduction purposes or are particularly relevant for waste reduction. Surveys tend to be one time events so that no time series information on waste generation is created, and they collect annual inventory data rather than waste generation per production output. They can identify major sources of chemicals, and this information can be valuable for setting program priorities. New Jersey's Industrial Chemical Survey is one of the best known. It is probably the most comprehensive of these efforts and was the basis for the national inventory system provision in the Senate Superfund reauthorization bill.

New Jersey's Industrial Chemical Survey collected 1978 data on 155 chemicals from 7,000 plants representing a wide variety of manufacturers and users in the State. This one-time survey requested annual, plant-level mass balance data on the amount of each chemical purchased; the amount shipped as product; the maximum amount in inventory; and the amounts present in the air, water, and solid waste streams. The survey cost New Jersey approximately $200,000 to complete, and State officials have reported that few claims of confidentiality were made by firms.

In 1986 New Jersey began collecting new information under its right-to-know legislation; this survey will be repeated every 2 years. It covers firms that produce, use, or store any of 154 hazardous substances. Most firms only need complete Part I, giving a range of the maximum inventory of the chemicals on hand at any one time during the year. In Part II, estimated plant-level mass balances of the chemicals must be reported. In one section firms are asked if any methodologies are being employed to "achieve source reduction or waste avoidance of generated [RCRA] wastes."[11] If the answer is yes, the respondent is given two lines in which to describe those methodologies. What is not clear is how New Jersey officials intend to use the responses to this question. As is the case with the Federal waste minimization reporting requirement, an endless variety of narratives may result for which no aggregation will be possible.

Maryland has a Toxic Substances Registry that contains an inventory of specific chemicals and facilities that use, manufacture, or process them. Much of the information is considered confidential and is collected for and used primarily by State agencies for program development. For instance, one survey was conducted in 1985 on 300 chemicals of interest to the State air toxics program. Twelve hundred firms were surveyed (90 percent response rate) on their use, production, and handling of the listed chemicals; no emissions data was requested.

New York State has conducted an Industrial Chemical Survey to collect information on 142 chemicals used, stored, manufactured, or transported in the State to improve local emergency response procedures. The State Attorney General in assessing the information said that, while it is valuable, much is classified as trade secrets, is now outdated, and only covers larger firms in the State.[12]

WAYS TO MEASURE WASTE REDUCTION

Questions about how much waste is currently being generated and how that figure is being reduced (or increased) over time *should* be answerable with data on waste generation. However, as discussed earlier, **true waste reduction may be disguised in waste generation trends by changes in production, changes in the amount of nonhazardous constituents in waste streams, regulatory changes, and cross-media shifts**. Existing waste generation data are therefore not useful for answering waste reduction questions because: 1) they deal only with some fraction of hazardous wastes, often only with wastes regulated under a single statute (e.g., RCRA wastes); 2) they are mass or volume estimates only; and 3) they are in no way correlated to production.

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[11] New Jersey Environmental Survey, Part II, Question No. 14. The questionnaire defines source reduction and waste avoidance activities as those activities that OTA considers waste reduction. However, although the survey covers all media releases, this waste reduction question only applies to RCRA hazardous wastes.

[12] Robert Abrams, Attorney General, State of New York, "Toxic Chemical Accidents in New York State: The Risk of Another Bhopal," Jan. 14, 1986.

Most hazardous wastes are complex mixtures of hazardous and nonhazardous constituents. Very often water is the largest component of raw waste streams that contain only small amounts of hazardous substances. Thus, volume reduction measurements by themselves reveal nothing about the hazardous portion of any waste stream. Concentration of hazardous substances alone is not waste reduction. Similarly, waste generation depends on production; trends in data not correlated to production may indicate a rise or fall in waste generation attributable only to an increase or decrease in capacity utilization of a plant or operation. Finally, reduction in one waste stream does not necessarily mean that total emissions of a substance have been reduced; most operations have several points of emission for any given substance and discharge wastes into more than one environmental medium.

Theoretical Requirements for Measuring Waste Reduction

Simply charting trends in waste generation data as it is now collected is not an adequate measurement of waste reduction. But, what would be adequate? **Theoretically, the only meaningful measure of waste reduction is the total amount of hazardous waste generated per unit of production**. This is the only way to compensate for the production, volume, and multimedia limitations of existing data.

As outlined below, such a measurement would require a large amount of very detailed process- and substance-specific waste information collected periodically on a production output basis. There are many reasons why collecting this amount and type of data may be impractical, but understanding what data are theoretically required to assess waste reduction will illustrate some of the risks and uncertainties incurred by accepting imperfect and, perhaps, misleading data.

Measurement Criteria

To provide a complete and reliable measurement of waste reduction, waste generation data collection methods would have to be changed to meet the following criteria.

Criterion 1: Waste Reduction Data Must Be Correlated to Production.—Because waste generation varies directly with capacity utilization (everything else remaining the same), it is important to know whether waste amounts are rising and falling because more or less product is being manufactured or because waste reduction measures are being implemented. *Waste generation figures not correlated to production can mask waste reduction successes as well as failures.* A company may be implementing waste reduction as its business is growing. Waste volumes may appear to be going up while waste per unit product, the true measure of waste reduction, is actually going down.

Thus, it may be to the advantage of companies to measure waste generation on a per unit product basis. For example, Monsanto Co. found that in terms of absolute volume their waste generation decreased only 1.7 percent between 1982 and 1984. However, unit generation (pounds of waste/pounds of production) decreased by 19.7 percent over that period.[13] Similarly, the plating operation at Stanadyne, Inc. (Sanford, North Carolina), calculated that its waste sludge had decreased only 4 percent between 1983 and 1985, from 115,000 pounds to 110,000 pounds. But annual production hours had nearly doubled over this period from 2,380 to 4,550, therefore waste generation dropped from 48.3 to 24.2 pounds per hour of production—almost a 50-percent decrease.[14]

Criterion 2: Waste Reduction Information Must Be Substance-Specific.—This is the only way to overcome the volume measurement problem and the media shifting problem. When waste streams are complex mixtures of hazardous and nonhazardous substances, volume measurements do not give the amount of hazardous substances in the waste, much less the amount of any given hazardous substance. One might hope to gather this information by intensively monitoring waste streams for their hazardous constituents, however such a procedure would assume that all releases were known. Fugitive air emissions, leaks, and spills can contain substantial amounts of hazardous materials and would almost certainly not be accounted for in such a system.

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[13] *Waste Reduction: The Untold Story*, proceedings of a League of Women Voters conference, Woods Hole, MA, June 1985.

[14] George McRae, Stanadyne, Inc., personal communication, Apr. 23, 1986.

In theory it is simple to calculate the amount of a specific substance appearing as waste in a process. One subtracts the amount of the substance in the product from the amount of the substance in the raw material; the difference is waste. A company would then know how much of that substance must be accounted for in all waste streams and emissions. Such a mass balance calculation for specific substances keeps nonhazardous constituents from diluting the usefulness of hazardous waste data. Also, by forcing an accounting of *all* emissions throughout the process, it finds previously unknown sources of waste which may aid in planning waste reduction.

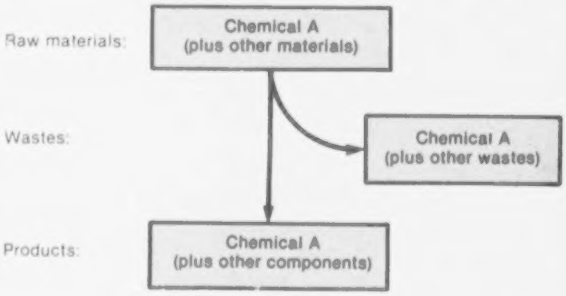
In practice, however, mass balance calculations are not always easy to conduct or reliable. There is *always* uncertainty in input and output measurements. When the inputs and outputs are large relative to the difference between them, the uncertainties may be larger than the amount of waste. Thus, these types of calculations may reveal little or nothing about small quantities of highly hazardous wastes.

Process chemistry can create additional practical difficulties in calculating mass balances. Figure 4-1 illustrates three basic chemical scenarios which pose varying degrees of difficulty.

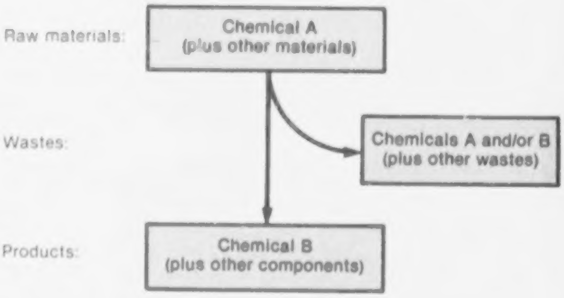
In Case 1, a hazardous Chemical A is used as a raw material that is incorporated into a product with some of it lost in the process. An example would be the use of cadmium metal in a cadmium plating operation, which generates cadmium wastes in the process.

Figure 4-1.—Process Chemistry Changes That May Affect Mass Balance Calculations

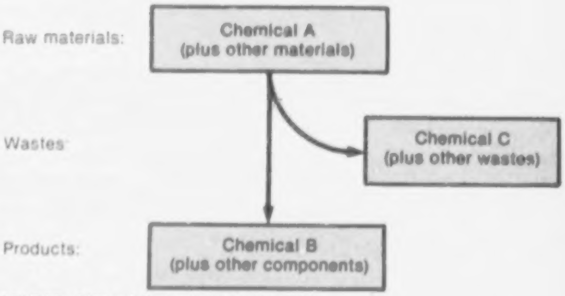
Case 1: Chemical A is not changed in the production process. (Chemical A is a hazardous substance.)


Raw materials:
Chemical A (plus other materials)
Wastes:
Chemical A (plus other wastes)
Products:
Chemical A (plus other components)

Case 2: Chemical A is converted into Chemical B in the production process. (At least one of the two chemicals, A & B, is hazardous.)


Raw materials:
Chemical A (plus other materials)
Wastes:
Chemicals A and/or B (plus other wastes)
Products:
Chemical B (plus other components)

Case 3: Chemical A is converted into Chemical B, producing the unintended hazardous byproduct, Chemical C. (Chemicals A & B may or may not be hazardous.)


Raw materials:
Chemical A (plus other materials)
Wastes:
Chemical C (plus other wastes)
Products:
Chemical B (plus other components)

SOURCE: Office of Technology Assessment.

In Case 2, Chemical A is converted into Chemical B. At least one of these chemicals is hazardous, and some of that hazardous input or product finds its way into the waste stream.

For example, the process used in the 1970s to convert vinyl chloride gas, a known carcinogen, into polyvinyl chloride (PVC) plastic resin allowed the release of some of the vinyl chloride gas.

In Case 3, Chemical A is converted into Chemical B, producing the unwanted hazardous waste byproduct, Chemical C. An example of this is the generation of highly toxic 2,3,7,8-tetrachlorodibenzo-p-dioxin (usually referred to as "dioxin") during the chlorination of a number of aromatic hydrocarbons, a process used in the manufacture of pesticides.

Even at this simple level, it is obvious that chemical alterations that occur in instances such as Case 2 and, particularly, Case 3 complicate the mass balance calculation. Calculating mass balances for complex industrial processes which involve many substances and many complex chemical reactions is a monumental task.

Criterion 3: Waste Reduction Data Must Be Process-Specific.—Conducting mass balance calculations at the plant level with a high degree of sensitivity and accuracy would be extraordinarily difficult. Processes, reactions, and transformations are usually so complex that good data cannot be collected except at the smallest production level—the process or unit operation. It might be possible in some cases to conduct a very rough mass balance on a hazardous substance at the plant level by figuring the difference between input and product output and assuming the rest is waste, without trying to track that waste. Doing this over time, one might get a rough sense of the amount of waste reduction, but the uncertainties in this calculation are almost always large and may not reveal much about small amounts of highly hazardous waste. **Moreover, a plant-level mass balance would not normally provide any guide for waste reduction action because it tells little about where the substance appears as waste in the plant operations.**

One illustration of the limitations of plant-level mass balances is the case of a leaking valve at USS Chemicals that was emitting 400,000 pounds of cumene worth $100,000 annually. The plant uses 700 million pounds of cumene annually and had conducted a cumene mass balance with an accuracy of plus or minus 1 percent. The valve loss, which accounted for only 0.06 percent of the raw material, could not be detected by this means.[15]

Criterion 4: Waste Reduction Data Must Be Collected Periodically.—This may sound obvious, but it is not always done. Without time series data on waste generation, waste reduction cannot be calculated. Government information collection efforts about wastes, in particular, are frequently one-time events or a series of events which cannot be compared.

Practical Constraints on Waste Reduction Measurements

There are several practical reasons why perfect waste reduction information can never be assembled by government. Some of these have already been alluded to. First, not all industrial operations lend themselves to measurement of waste on a production output basis because *units of production or output are often not easy to establish*. This is particularly true in service industry job shops such as autobody shops where significant amounts of solvents may be used but in a mix of applications which can not be easily correlated to sales, profits, or hours of operation. Similarly, in many batch processes, such as dye mixing and specialty chemical formulation where both product and waste vary in type and quantity, a meaningful measure of unit production may be difficult, but not impossible, to establish.

Second, *the amount of data theoretically needed to assess waste reduction is staggering*. Collecting process-level mass balance data on every single hazardous substance from every plant in the country is impossible.

Third, *many companies consider detailed data on their processes to be proprietary*. Companies may fear that, if made public, this information could be useful to their competitors and may therefore strongly resist reporting such data.

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[15] David J. Sarokin, et al., *Cutting Chemical Wastes* (New York: INFORM, Inc., 1985).

Fourth, even if industry had the resources to collect and report this kind of data, *government has not yet demonstrated its ability to efficiently and effectively manage the data on wastes that it currently requires from industry. A data deluge of this magnitude would be overwhelming.*

But, government does not necessarily need a huge amount of disaggregated process-level information. Policymakers need a few crucial numbers to understand the crucial questions about waste reduction. Examination of current waste generation figures reveals uncertainties arising from nonhazardous constituents, cross-media shifting, and variations in production. However, once generation figures are substance- and process-specific and corrected for production volume they appear difficult to aggregate. The problem becomes one of how to combine:

- X metric tonnes of TCE waste/year of autobody degreasing,
- Y metric tonnes TCE waste/meter of fabric scoured, and
- Z metric tonnes TCE waste/10,000 doorknobs cleaned to obtain plant- or company-level information.

PRACTICAL POSSIBILITIES FOR INFORMATION COLLECTION

Pooling Waste Reduction Data

One way for government to obtain waste reduction data without invading the proprietary domain of industry is for companies to pool their waste reduction data in the form of waste reduction *percentages*.

Pooling works as follows: a company calculates the absolute amount of a particular waste generated at the process level per unit production output per year.[16] It then converts that figure into a percentage reduction (or increase) relative to the last year's generation. The percentages can be combined across different processes, plants, or industries by using weighted averages.[17] An A percent reduction in a waste stream of X tonnes/year, a B percent reduction in a stream of Y tonnes/year and a C percent reduction in a waste stream of Z tonnes/year is a combined reduction of the total waste stream of X+Y+Z of:

$$A(X/X+Y+Z) + B(Y/X+Y+Z) + C(Z/X+Y+Z) = \begin{array}{c}\text{average}\\ \text{reduction}\end{array}$$

Since the waste data is volume data, this approach does not necessarily reveal anything about the degree of hazard or environmental risks posed by the waste. However, when substance-specific data are available, this approach can make such determinations.

In this way, a company can pool its process-level reduction figures into one plant-level reduction figure for each waste. All the-plant level reduction figures can then be pooled into one company reduction figure. Similarly, company figures can be pooled into single reduction figures for States, industrial sectors, or the entire country. (See box 1-D in ch. 1.)

Government could choose whether it wanted companies to report at the plant or company level. In either case, *pooled percentages conceal information about company processes which can be of use to competitors, thereby alleviating industry's concerns about confidentiality*. The pooling system also greatly limits the amount of data the government will receive and will have to manage.

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[16] A variety of ways to calculate waste reduction as related to production output have been used in industry. Some are simple variations on the method presented here. For example, measuring percentage waste reduction per unit production in any particular year against some standard baseline year (much the way economists measure in constant dollars) is perfectly valid. It differs from OTA's method only in that it presents sums of waste reduction percentages over all years since the baseline year, rather than reporting reduction as individual annual percentage changes. This method may be more useful for long-term trends but less revealing about activity in any given year. However, OTA considers some other methods currently used to be less accurate. For example, measuring percentage waste reduction as a function of revenues may not be reliable, because product changes and price changes prevent revenues from directly reflecting production.

[17] Without weighting reduction percentages to reflect the different sizes of waste streams reduced, the averages may be misleading. A large percentage reduction in a small waste stream could skew the average to give an overly positive picture of the average waste reduction. Similarly, the importance of a small percentage reduction in a large stream would not be adequately represented without proper weighting of the percentages in the average.

Screening for Changes in Degree of Hazard

The pooled figures correctly measure the reduction in volume or mass of waste generated but they do not necessarily reveal anything about the amount of hazardous constituents in the waste or their degree of hazard. A waste reduction action may have little effect on the degree of hazard of a waste for two reasons. First, the concentration of the hazardous constituents in the waste may change. This is a problem of particular concern in measuring reduction in aqueous waste streams, which make up much of the national waste output. The great majority of wastewater streams are 90 percent or more water. With so much water, volume and mass measurements easily cloud waste reduction measurement. Reducing the amount of process water can significantly reduce the volume of an aqueous waste; the waste stream becomes more concentrated, with no reduction in hazardous content. Conversely, if the hazardous constituent in a dilute waste stream is significantly reduced, only a very small reduction would be measured when in fact significant waste reduction had occurred.

Second, the chemistry of the waste may change because of a waste reduction action and cloud substance-specific reduction measurements as well as mass or volume measurements. Data indicating that one particular hazardous constituent has been eliminated from a waste stream reveal nothing about any newly generated hazardous constituents. For example, TCE may be eliminated from a waste stream but if methyl chloroform has been substituted, the amount of hazardous wastes generated may not have been reduced. Similarly, if a waste reduction action involves substituting new raw materials that produce a smaller quantity of a more hazardous waste, true waste reduction has not occurred.

To understand and analyze reduction measurements involving changes in chemistry and concentration of wastes requires detailed data on the composition of the waste and the action(s) that brought about the change. In most cases this is likely to be cumbersome even for the industries directly involved, let alone for the government. However, it may be enough for government to screen out such data and not use them in its calculations of national waste reduction.

Limiting Data Collection/ Living With Imperfect Data

Clearly the data required for accurate waste reduction measurement are extremely difficult to obtain in practice. However, establishing a method for acquiring *some* useful data, even incomplete or imperfect data, would be an improvement over the current situation in which virtually *no* meaningful waste reduction data is available. Government has at least three *nonexclusive* options for drastically limiting the collection effort for waste reduction data and still learn something about waste reducing activities in American industry.

Option 1

Government could forego substance-specific data and require that simple waste volume (or mass) generation data be correlated to production output, as described above, and reported in terms of percent reduction. These data would suffer because they would treat water and other nonhazardous constituents as wastes, but they would at least incorporate economic activity into waste reduction figures. Such facts would also be relatively straightforward and inexpensive for industry to collect, and even this limited information would be an improvement over the current situation.

Option 2

Government could require substance-specific data correlated to production output on only a few substances of particular concern, perhaps gradually increasing this number over time. This option would be most useful if implemented in conjunction with Option 1. The two could be implemented concurrently (i.e., volume/production data on most wastes, with substance-specific data on a few substances) or sequentially (initiate volume/production collection, phasing in requirements for substance-specific data on substances of concern).

Option 3

Government could require simple waste volume (or mass) data correlated to production output but could screen these data for changes in degree of hazard. Government could require that for each reduction percentage reported, companies answer two questions: Has any change in concentration in the waste accompanied this reduction? Has any change in the chemistry of the waste accompanied this reduction? Government could then reject any data about which positive responses were given in calculating national waste reduction figures, because without further information the amount of true waste reduction in those instances cannot be verified. Alternatively, the government could require and analyze additional information to determine if true waste reduction had taken place. This, however, could become a very large task.

These options to reduce the quantity of data industry would be required to report to government could lift an enormous burden off both government and industry. The options may not, however, completely solve a number of the practical constraints on data collection cited earlier, such as analyzing the chemistry of a large number of waste streams and putting together an overall waste reduction picture from disaggregated data.

INFORMATION REQUIREMENTS AND OPTIONS FOR FEDERAL ACTION

The information the Federal Government might want in order to assess the need for waste reduction or act on this need will depend on the action contemplated. Table 4-4 lists several possibilities for Federal action and notes the information that might be needed to choose and/or implement them. It is clear from the table that the information requirements of some of the options are formidable.

Mandatory Reduction Levels

The amount of data and information that would be required both to set and to enforce mandatory waste reduction standards would quickly overwhelm the regulatory process as it now exists. The government might implement this option in the same way it has approached the setting and enforcing of Clean Water Act effluent limitations and standards, but it would be much harder for waste reduction. EPA would need, first, a vast amount of technology information on all industrial processes that release hazardous substances into the environment in order to determine what levels of waste reduction could reasonably be expected using best available technology (BAT) for each process. This assumes that industrial processes can easily be broken up into generic types that will be similar enough to be regulated under one BAT standard. Even if generic divisions could be established, industrial diversity and site-specific exceptions would be likely to force many companies to petition for variances, as has been the case under the Clean Water Act standards. Since BAT for waste reduction will have to be part of production technology, rather than an add-on treatment technology, one must assume that the diversity and variance requirements will be substantially larger. The continuous need to assess variances would inundate the government with further data and information to manage.

Second, standard-setting would be never-ending. As new industrial processes are developed and old ones are modified, new BAT standards would have to be set. In addition, as more is learned about waste reduction, BAT may change and new waste reducing techniques may be identified and need to be incorporated.

Table 4-4.—Information Needs for Different Waste Reduction Actions by the Federal Goverment

Possible government action	Information needed	Type(s)
Assessing the waste reduction problem, setting priorities, and choosing an option for action:	Will vary depending on depth of analysis, but may include:	
	• reliable national waste generation data, preferably on a substance-specific and production/output basis;	W,P
	• reliable data on national waste reduction (or increases) to date;	W,P
	• information on the amount of further waste reduction that might be technically possible in different industries nationally;	T,P
	• cost and ease of various waste reduction measures both for industry and for government;	E,T,P,W
	• degree of hazard of different types of wastes to aid in targeting actions; and	H
	• already existing government programs that encourage waste reduction.	R
No immediate action:	Updated assessment information (above) so that changes can be monitored and for changes which may require action.	
Nonregulatory options:		
Technical Assistance and Education Program	Waste reduction techniques and opportunities in a wide variety of industries.	T
	Implementation and success rates of waste reduction in companies assisted so can evaluate program and justify continued funding.	W,E
Economic Incentives Program (tax breaks, grants, low-interest loans)	Costs of waste reduction activities.	E
	Implementation and waste reduction success of companies assisted so can evaluate program and justify continued funding.	W,E
Regulatory incentives (extended permit lives, expedited delisting of certain wastes for companies demonstrating true waste reduction)	Current regulations and the current regulatory climate.	R
	Actual waste reduction achieved v. any sacrifices made so that trade-offs can be justified.	W,H
Regulatory options:		
Mandatory waste reduction levels:		
1. Targeting wastes of concern	Waste stream contents and amounts.	W
2. Setting appropriate levels for each industry	Waste reduction potential in each industry.	T,P,E,W
3. Enforcement	Continual updates on all of the above information.	T,P,E,W
Increased mandatory reporting of waste reduction activities, for example, requiring: • More detailed reporting of waste reduction plans in place • Reporting of hard data on wastes reduced • Reporting of waste reduction data on a production output basis	None. However, it is important that government know why it is requiring this reporting. If purpose is simply to force industry to collect this data so industry will be more alert to waste reduction possibilities, then government need do little, but if the purpose is also to compile some useful data on industry activities, the government must have some way of managing an enormous quantity of incoming data so that it is accessible. Current management systems would not be adequate.	

KEY: Type W = Waste stream data.
Type P = Production information.
Type E = Economic information.
Type T = Technology information.
Type R = Regulatory information.
Type H = Health and environmental effects information.

SOURCE: Office of Technology Assessment, 1986.

Third, EPA would have to enforce these standards. Presumably, companies would be required to report waste generation figures—perhaps by process and/or substance and/or unit output—at regular intervals. Those figures, even at the grossest level of total volume generated per plant for most industrial plants in the country, would quickly swamp EPA. A massive inflow of information of this kind could not even begin to be managed with existing resources since EPA does not have the resources to manage the data it already receives and current compliance with regulatory programs of this type is low.

Mandatory Increased Information Collection

A milder regulatory option open to the Federal Government would be to increase mandatory reporting of waste reduction information, including, perhaps, more detailed waste reduction plans, but to set no enforceable standards or waste reduction targets for industries. This eliminates the need for standard-setting and enforcement but is still likely to produce a flood of information which government currently cannot manage. It is therefore important that before choosing this option, policymakers decide why they want more information and what they plan to do with it. The purpose may simply be to stimulate industry to be more alert to waste reduction possibilities. If so, government need not be very concerned about analyzing or using the information. Government may even decide not to require reporting but to require that industry have the information available for in-house scrutiny by EPA or State officials. (This is similar to the current waste minimization reporting requirements under RCRA.) If, on the other hand, government wishes to compile waste reduction information for its own use, government must create advanced new systems to collect and manage incoming data.

Nonregulatory Options

Nonregulatory options generally require much less information and make fewer demands on data management systems. The primary requirements are for data for planning and priority setting among these options. The government would probably want some information on significant obstacles to waste reduction and would want to know where companies most need assistance in reducing their waste before deciding what program(s) would be most effective. Similarly, government would probably also require information on the effectiveness of these programs after they are instituted in order to justify continued funding. As a practical matter, it is not necessary that either type of information be provided in great detail; government has made many decisions to authorize and continue funding programs based on limited data as to their effectiveness.

No New Major Action

In order to make a considered decision that government should take no major action, some amount of the planning and priority-setting information necessary for all other options would be needed.

CASE STUDIES: INFORMATION AVAILABLE ON TWO HAZARDOUS SUBSTANCES

To illustrate the information currently being collected on hazardous substances and its lack of usefulness for waste reduction efforts, OTA reviewed the information gathered on two hazardous substances—cadmium and trichloroethylene (TCE). Neither of these substances is representative of the universe of hazardous substances. Both were recognized decades ago as having potentially hazardous properties, and each has an extensive history of scrutiny under a wide variety of regulatory statutes. Much more information has therefore been generated about cadmium and TCE than about most other hazardous substances in industrial use today.

Cadmium and TCE were chosen, not only because there was a great deal of information about them, but also because they represent very different classes of hazardous substances with different lifecycles and industrial uses. Trichloroethylene is a liquid synthetic organic chemical used widely as a solvent. TCE is typical of synthetic organic chemicals: it is manufactured, it is used by the chemical industry to make other chemicals, it is widely used in other industries, and it can be destroyed by a variety of waste treatment processes or allowed to degrade in the environment.

In contrast, cadmium is an elemental metal. As such, it cannot be destroyed. Once dug up from the ground, typically as a component of zinc or copper ore, 100 percent of it must be disposed of in the environment. In addition to appearing in its pure metal form, cadmium is found as a component of hundreds of different chemicals, most of which share its toxic properties. Thus, when one refers to cadmium as a substance of environmental concern, usually both metallic cadmium and its compounds are being discussed. Cadmium and its compounds are generally easier to detect and quantify in waste streams and the environment than are most organic compounds, such as TCE.

For cadmium and TCE, the case studies examined the quantity and quality of information available to the Federal Government about:

1. public health and environmental hazards;
2. industrial uses that result in waste generation and possible waste-reducing approaches (e.g., substitutions);
3. extent of generation as a waste nationally and at individual industrial plants (including all types of emissions, releases, and discharges into the environment); and
4. regulation and the ways in which regulatory activities have affected its waste generation nationally.

Cadmium Case Study

Summary

Cadmium is an elemental metal long known to cause serious kidney, respiratory, and cardiovascular effects. More recent evidence from animal studies suggests that cadmium may also cause cancer.

Cadmium is mined only as a byproduct of other metals, usually zinc, but also copper and lead. It must be separated from these ores during processing; the total cadmium supply is heavily dependent on the production of these other materials. Because the supply of cadmium is determined by the demand for zinc, the price of cadmium is dependent only on its demand and can fluctuate widely. Ultimately, because an element cannot be destroyed, all cadmium mined eventually becomes waste: during mining and extraction, during manufacturing and industrial use, or after the disposal of cadmium-containing products.

Despite massive efforts, the national materials balance of cadmium is unknown because of the highly complex dispersion paths of the metal through the economy and into the environment. Different studies ascribe the major industrial sources of cadmium in the environment to: 1) mineral processing and use in various industrial applications (e.g., electroplating, battery manufacture); or 2) the burning of coal and other fuels containing traces of the metal.

Extremely imprecise estimates project that about half of cadmium wastes initially go to the air, about a quarter go directly to land, and another quarter are discharged into waste water streams.[18] Whatever the nature of the original discharge, cadmium rapidly binds to soils and sediments and then concentrates in biological materials, particularly leafy vegetables grown on contaminated soils. As a result, foods are the largest source of human exposure to cadmium.

Cadmium has a long history of regulation, but it is not clear what effect regulations have had on the amount of cadmium used in industry and whether regulations have prompted cadmium waste reduction by industries. The opportunities for cadmium waste reduction are complicated by the fact that the total supply is so dependent on the production of other materials and that all of that supply must eventually become waste. Major cadmium legislation and regulations are presented in table 4-5.

Industrial Use of Cadmium[19]

Cadmium coatings are particularly useful in the electrical, electronic, automotive, and aerospace industries. Cadmium is also important in a number of other capacities. It is used in the negative plates of batteries. Cadmium pigments offer high-temperature stability, brilliant colors and high opacity, resistance to chemical attack and degradation by light, and good dispersion characteristics in plastics and paints. Cadmium compounds are also used as stabilizers in both flexible and rigid types of polyvinyl chloride to retard the degradation process caused by heat and light.

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[18] JRB Associates, Inc., "Level II Materials Balance: Cadmium," draft contractor report prepared for EPA's Office of Pesticides and Toxic Substances, Survey and Analysis Division, Mar. 21, 1980.

[19] U.S. Department of the Interior, Bureau of Mines, *Mineral Facts and Problems*, 1985 edition.

Table 4-5.—Major Legislation and Regulations Pertaining to Cadmium (Cd)

Statute:	Action(s) taken
Clean Air Act:	Intent to list Cd as a hazardous air pollutant published Nov. 16, 1985, based in part on EPA's conclusion that Cd is a probable human carcinogen. Decision to list will rely on pollution control techniques for Cd and further public health risk analysis.
Safe Drinking Water Act:	National Interim Primary Drinking Water Standards (NIPDWS) of 0.01 milligrams/liter set December 1975 was intended to include a fourfold safety factor to reduce the earliest manifestations of chronic Cd poisoning.
Clean Water Act:	Water quality criterion for Cd to protect human health is identical to NIPDWS, 0.01 mg/l; set Mar. 15, 1979.
	Ocean dumping banned for all but trace amount of Cd (proposed Jan. 11, 1977, finalized Jan. 6, 1978).
	"Reportable quantities" of cadmium acetate, cadmium bromide, cadmium chloride set at 100 lb in 1979. Discharge of more than the reportable quantity into navigable waters within a 24-hour period must be reported to National Response Center.
	Cd and Cd compounds were specifically designated in list of 65 priority toxic pollutants or pollutant categories. Cd and Cd compounds are regulated for specified industrial point sources.
	Applicants for NPDES permits in certain primary industrial categories with processes which discharge Cd or Cd compounds must report quantitative data on Cd discharge at each outfall.
Resource Conservation and Recovery Act (RCRA):	Solid waste classified as toxic hazardous waste, if passes toxicity test.
	Wastewater treatment sludges from electroplating operations are designated as hazardous in part because of their Cd content.
	Emission control dust/sludge from the primary production of steel in electric furnaces and from secondary lead smelting are regulated as hazardous in part because of their Cd content.
	All of these designated hazardous wastes are subject to the "cradle-to-grave" manifest system that covers generators, transportation, storage, and disposal of such wastes.
	Groundwater cannot be contaminated beyond the facility boundary at Cd levels in excess of 0.01 mg/l.
	Oil containing more than 2 ppm Cd is restricted for burning.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	Tax of $4.45/ton on manufacturers, producers, and importers of Cd.
	Tax on receipt of waste containing Cd of $2.13/dry weight ton.
	Reportable quantity of 1 lb for Cd and 100 lb for Cd acetate, Cd bromide, and Cd chloride released into the environment. Cd particles need not be reported if larger than 100 micrometers.
Occupational Safety and Health Act:	Average exposure limit of 0.1 mg/m^3 of Cd fume and 0.2 mg/m^3 of Cd dust; maximum exposures: 0.3 mg/m^3 and 0.6 mg/m^3 respectively.
Mine Safety and Health Act:	Maximum air concentrations of Cd established for different types of mining operations.
Federal Food, Drug, and Cosmetic Act:	Same standards as NIPDWS—0.01 mg/l.
Hazardous Materials Transportation Act:	Has established rules governing transport of cadmium acetate, cadmium bromide, and cadmium chloride.

SOURCE: Office of Technology Assessment, 1986.

Substitutes for Cadmium[20]

There are a number of possible substitutes for cadmium. For electroplating, zinc can be substituted for cadmium except for applications in alkaline environments or when the plate must be exceptionally thin. Aluminum platings have also been successfully substituted for cadmium platings in recent years. The best substitutes for cadmium in paints and pigments are other inorganic compounds, but they are often less brilliant in color and lack cadmium's stability, which is especially important in high-temperature molding of plastics.

Organotin compounds are the most efficient stabilizers known for polyvinyl chloride, but they are much more expensive than cadmium. Lead stabilizers are relatively cheap and effective, but they are also toxic. The lead-acid battery is the lowest cost substitute for cadmium batteries. They are easily recharged and have more capacity but are less dependable and have a shorter life than cadmium batteries.

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[20] Ibid.

Transport and Transformation in the Environment

There is less information on the environmental movements of cadmium waste than there is on its health effects. Because cadmium is a stable element and does not have a half-life for destruction, the amount of cadmium in the surface environment can only increase.

The metal and its compounds move through the environment in a variety of ways. Cadmium is first introduced into the surface environment during mining. The volatility of the metal allows release of cadmium vapors during thermal processes, such as ore roasting and smelting, as well as during incineration of wastes and combustion of fossil fuels. Cadmium vapor reacts with carbon dioxide, oxygen, or water vapor in the air to form cadmium carbonate, cadmium oxide, or cadmium hydroxide salts.[21] Atmospheric releases of cadmium eventually settle on lands and surface waters where they bind to soils and sediments.

In a recent report, EPA's Office of Water Regulations and Standards (OWRS) suggested that deposition through dispersion of atmospheric emissions can affect essentially all cropland, although the intensity of deposition is very low.[22] By contrast, since cadmium is known to accumulate in sewer sludge, land spreading of sludge can cause intense cadmium contamination in very small areas. OWRS estimates that as much as 400 metric tons per year (mt/yr) of cadmium may reach cropland topsoil via phosphate fertilizer,[23] as much as 140 mt/yr via emissions deposition, and as much as 70 mt/yr from sludge land spreading. Cadmium can also be eroded from crop topsoil and transported to streams and stream sediments; figures on quantities transported in this manner are presented by OWRS with some caution.

Data Used for Legislation and Regulations

In general, each regulation is supported by some amount of: 1) health effects data; 2) exposure data, often in the form of environmental release data; and 3) health risk assessment data, which is based on the first two.

One instructive example is EPA's notice of intent to list cadmium as a hazardous air pollutant under Section 112 of the Clean Air Act.[24] Although this action is only a notice of intent to regulate and thus can be based on less information than required for a full regulation, the type and amount of data on which this action is based is of interest because: 1) it is one of EPA's most recent actions involving cadmium and thus is based on the most current data; and 2) it is probably similar to the type, amount, and quality of data currently available to Congress or EPA if either were to take action on waste reduction for cadmium.

EPA makes clear in its intent to list notice that data on sources and levels of cadmium emissions are problematic:

> The present estimates of cadmium emissions are subject to several sources of uncertainty. These include a general lack of source-specific information that requires the use of simplifying assumptions (e.g., the use of average values for the cadmium content of fossil fuels, municipal waste, and sewage sludge). A second source of uncertainty concerns the levels and effectiveness of current emission controls. The EPA is aware that a number of the identified source categories are already reducing emissions of cadmium through equipment installed to control total suspended particulate matter and lead. There are questions concerning whether the control efficiency for cadmium emissions are equivalent/similar to the control efficiency for total particulate emissions.[25]

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[21] U.S. Environmental Protection Agency, *Intermedia Priority Pollutant Guidance Document: Cadmium*, July 1982.

[22] U.S. Environmental Protection Agency, *Cadmium Contamination of the Environment: An Assessment of Nationwide Risk*, EPA-440/4-85-023 (Washington, DC: Office of Water Regulations and Standards, February 1985).

[23] Phosphate fertilizer is contaminated with cadmium because cadmium has a natural association with phosphate minerals. The degree to which phosphate rock is contaminated with cadmium depends on the origin of the phosphate. [U.S. Environmental Protection Agency, *Cadmium Contamination of the Environment: An Assessment of Nationwide Risk*, op. cit, p. 25.

[24] 50 Federal Register 4200, Oct. 16, 1985. Specific documents relied on are listed in the Notice.

[25] 50 Federal Register 4200, Oct. 16, 1985.

EPA also noted that current source information is based on engineering estimates only. Before making a decision to list, EPA plans to improve its information by requesting data directly from source owners and making plant visits and source tests.

EPA also plans to request additional health effects data. EPA's 1981 Health Assessment Document emphasized the long-recognized kidney dysfunction problems as cadmium's principal health effect, and ingestion, rather than inhalation, as the principal path of cadmium exposure.[26] Recent studies suggesting cadmium's potential carcinogenicity prompted EPA to review and revise this document and classify cadmium as a probable human carcinogen.

Public exposure information was based on dispersion modeling, which may affect the quality of the data. EPA's Human Exposure Model estimates the cancer risk from cadmium exposure by using location and emission characteristics of actual or representative sources, combined with census and meteorological data to estimate the magnitude and distribution of population exposure. EPA notes that there are a number of assumptions underlying these estimates that can yield either over or under estimates of the risk posed by cadmium. These include estimating the carcinogenic potency of a substance through the use of a mathematical model for extrapolating high-dose worker or animal studies to the much lower concentrations present in the ambient air. EPA plans to improve these estimates before proceeding further with its listing procedures.

Despite the fact that EPA relied mostly on 1985 or updated data in its deliberations about whether to list cadmium as a hazardous air pollutant, it is clear from this brief overview that:

- EPA concluded that in most areas it had insufficient data, especially concerning sources of cadmium emissions, to promulgate a regulation at this time.
- Most of the data EPA uses and plans to collect to support this regulation are on health effects and public exposure, both of which are only peripherally related to waste reduction. The emissions data component of the exposure information, the most relevant to waste reduction because it is plant-specific, is the area in which EPA's data was the weakest.
- Much of the information EPA plans to collect will be sampling data to support modeling of exposure and dispersion. Such information will be only marginally relevant to waste reduction.

National Materials Balance

Several attempts have been made to conduct a national materials balance for cadmium. The most extensive effort, conducted in 1980,[27] shows as much about the difficulties involved in this massive effort as it shows about the amounts of cadmium and its movements through the country.

The study was ambitious. It took a year, cost $225,000, and attempted a Level II materials balance, which involves searching the published literature thoroughly and contacting trade associations, other agencies, and industry for unpublished information. A Level I materials balance would have entailed only a survey of readily available information, with many assumptions to account for gaps in information. A Level III balance would have collected new data from site visits and monitoring to fill in gaps in the Level II balance so that its results be would statistically valid.

The report has never progressed beyond draft form, in part because EPA's Office of Toxic Substances decided not to pursue regulation of cadmium, eliminating the reason for the materials balance. Further, EPA had strong reservations about some of the assumptions and estimates.[28] One reason for commissioning a Level II mass balance was that EPA hoped to eliminate some of the significant uncertainties in Level I mass balance calculations. Unfortunately, the dispersion pathways for cadmium are so complex that the contractor could do little but guess at estimates of cadmium quantities in particular sinks and at how imprecise their estimates might be. EPA's concern was that these estimates, although probably as reliable as the others, were not of Level II certainty.[29]

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[26] U.S. Environmental Protection Agency, *Health Assessment Document for Cadmium*, EPA-600/81-023, May 1981.

[27] JRB Associates, Inc., op. cit.

[28] Mike Callahan, Acting Director, Exposure Assessment Group, Office of Research and Development, U.S. Environmental Protection Agency, personal communication, June 10, 1986.

A study on cadmium in 1985[30] points to fossil fuel emissions as a much larger source of cadmium air emissions than ore refining which was identified in the earlier study as the major source. Another study supports the importance of fossil fuels as sources of atmospheric cadmium.[31] Discrepancies among the various materials balances are large, often by orders of magnitude, and often sources of release which appear to be significant in one study are not even listed in another. These areas of disagreement cast doubt on the accuracy of these materials balance studies and call into question the possibility of conducting a reliable national materials balance on cadmium.

One problem encountered in all cadmium materials balances is that cadmium dispersal is highly complex, both in relation to production and to use. Cadmium, a minor constituent in zinc, copper, and lead ore, is not entirely removed by refining. Thus, some cadmium is carried with its companion metals through their lifecycles. A significant fraction[32] of cadmium in use is associated with galvanized zinc, in which it is found as an impurity. Similarly, about a quarter of all cadmium sent to waste disposal facilities comes from phosphorus production, where cadmium is an impurity in the phosphorous mineral. Thus, data on the lifecycles of these other substances may be necessary for a complete understanding of the cadmium materials balance.

Another difficulty is the variation in cadmium content of fossil fuels, which account for a significant fraction of air emissions. The cadmium content of coal or petroleum products varies from reserve to reserve, from seam to seam, and even within seams.

Plant, Company, and Industry-Level Information

OTA attempted to find sample plant-level information on cadmium wastes, input, or product outputs but was unsuccessful. EPA's document, *Sources of Atmospheric Cadmium*, which did not examine plants but instead relied on references and models, concluded that: "very little information could be found about individual plants which manufacture products containing cadmium."[33]

Trichloroethylene Case Study

Summary

Trichloroethylene (TCE) is a volatile organic compound (VOC) known for decades to be toxic to the liver and nervous system. More recently there has been evidence suggesting its carcinogenicity.

Trichloroethylene is an inexpensive but effective solvent commonly used in degreasing operations of many kinds, particularly for metals, plastics, and textiles. It is also used as a stabilizer in the manufacture of polyvinyl chloride. TCE is produced at only two plants in the United States and is used as a chemical intermediary at about a dozen other plants. However, over 90 percent of all emissions into the environment are estimated to come from the tens of thousands of different industrial degreasing operations all around the country. Only a few tenths of 1 percent of all emissions are emitted during TCE production.

Because of its volatility, most TCE eventually finds its way into the air. Even TCE initially discharged into water or land will, in large part, volatilize. Estimates are that more than 85 percent of TCE is discharged into the atmosphere, where it is expected to degrade with a half-life of between 24 and 48 hours. Inhalation is by far the most common form of human exposure.

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[29] This is not to say that a Level II materials balance is impossible. JRB also did a Level II materials balance for benzene which EPA considers to be more reliable. [Callahan, op.cit.]

[30] U.S. Environmental Protection Agency, *Cadmium Contamination of the Environment: An Assessment of Nationwide Risk*, op. cit.

[31] GCA Corp., *Survey of Cadmium Emission Sources*, EPA-450/3-81-013, contractor report prepared for EPA's Office of Air Quality Planning and Standards, September 1981.

[32] Between 25 and 33 percent, according to the JRB study.

[33] U.S. Environmental Protection Agency, *Sources of Atmospheric Cadmium*, EPA-450/5-79-006, August 1979.

Trichloroethylene has a long history of regulation which may, in part, account for its rapidly declining use in industry. While this decline has obviously been accompanied by a decline in TCE wastes generated, the overall result may not be a decline in the amount of hazardous waste, since the principal substitutes for TCE have been other hazardous materials—methyl chloroform for metal degreasing and methyl chloroform and perchloroethylene for textile scouring. While these substitute materials are considered under current regulations to pose less risk to workers, when discharged into the environment they are known to be hazardous, although their effects are not well understood.

One interesting feature of TCE regulation is that it has been focused largely on TCE discharges into water, which are estimated to account for only 12 percent of TCE wastes. EPA is only now beginning to undertake regulation of TCE air emissions, which account for approximately 85 percent of TCE wastes. Major TCE legislation and regulations are presented in table 4-6.

Hazardous Characteristics and Health Effects[34]

TCE has been known since the early part of this century to have a wide variety of effects on the human nervous system including: headache, dizziness, vertigo, tremors, nausea, sleepiness, fatigue, lightheadedness, unconsciousness, and in some cases, death. Death related to TCE exposure is believed to result from cardiac arrest.

Recently TCE has been the subject of an active debate over its carcinogenic potential. After reviewing the evidence, EPA has concluded that sufficient evidence exists to warrant classifying TCE as a probable human carcinogen.

Industrial Use of TCE

Trichloroethylene is one of the most versatile and least expensive solvents used for degreasing—primarily for metals but also for plastic, glass, and textiles.[35]

In addition to being a solvent, TCE is used in the production of polyvinyl chloride, fungicides, adhesives, and cleaning fluids.[36]

Substitutes for TCE

Market factors, such as increased replacement of metals with plastics, as well as environmental and health concerns, have prompted substitution of methyl chloroform (1,1,1-trichloroethane) and other solvents for TCE. As a result, production and use of TCE have decreased since production peaked in 1970 at 277,000 metric tons per year (mt/yr). Production has been estimated at 146,000 mt/yr for 1978, 81,000 mt/yr for 1982, and 65,700 mt/yr for 1983.[37] A Level I Materials Balance for TCE, published in 1980, reported that TCE had already been widely replaced by methyl chloroform in the metal cleaning industry and by methyl chloroform and perchloroethylene in the textiles industry.[38]

Transport and Transformation in the Environment

There is less information on the environmental characteristics of this chemical than on its health effects. Most of the information must be pieced together from very disparate sources, and models tend to be used heavily where data is absent.

Volatilization is the major process by which TCE is removed from surface water. The half-

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[34] J. Doull, C.D. Klaasen, and M.O. Amdur, *Casarett and Doull's Toxicology* (New York: MacMillan Publishing Co., Inc., 1980). Also, U.S. Environmental Protection Agency, *Health Assessment Document for Trichloroethylene*, EPA/600/8-82/006F, July 1985. Also, Chemical Effects Information Task Force, Oak Ridge National Laboratory, *Trichloroethylene Health Effects*, Sept. 26, 1985.

[35] Arthur D. Little, Inc., and Acruex Corp., "An Exposure and Risk Assessment for Trichloroethylene," final draft, March 1981, revised October 1981, p. 3-16.

[36] Ibid., p. 3-24.

[37] J.J. Vandenberg, *Trichloroethylene Exposure and Cancer Risk Analysis*, Oct. 11, 1985.

[38] JRB Associates, Inc., "Level I Materials Balance: Trichloroethylene," draft interim contractor report prepared for EPA's Office of Pesticides and Toxic Substances, Survey and Analysis Division, April 1980.

Table 4-6.—Major Legislation and Regulations Pertaining to Trichloroethylene (TCE)

Statute:	Action(s) taken
Clean Air Act:	Intent to list TCE as a hazardous air pollutant published Dec. 23, 1985, based in part on EPA's conclusion that TCE is a probable human carcinogen. Decision to list will rely on possibilities for pollution control techniques and further public health risk analysis.
	Standards of Performance, promulgated Oct. 18, 1983, for new stationary sources covers producers of TCE as an intermediate or final product.
	Required reporting of TCE emissions, emission levels, emission control techniques, production volumes, sales and purchase data for 15 plants known to produce (directly or as a byproduct) or use TCE under Section 114 for EPA's recent report, "Survey of Trichloroethylene Emission Sources."
Safe Drinking Water Act:	EPA promulgated a Recommended Maximum Containment Level (RMCL) for TCE of zero (Nov. 13, 1985) because of the Agency's conclusion that TCE is a probable human carcinogen. RMCLs are nonenforceable. At the same time EPA proposed a Maximum Containment Level (MCL) of 0.005 mg/l for TCE in drinking water. MCLs are enforceable and are set as close to RMCLs as feasible, given technologies and costs.
	TCE is regulated as a hazardous waste under the Underground Injection Control Program.
Clean Water Act:	"Reportable quantity" of TCE set at 1,000 lbs in 1979. Any discharge into navigable waters in excess of the reportable quantity in a 24-hour period must be reported to the National Response Center.
	NPDES permit applicants in specific industrial categories must provide quantitative data on TCE discharge from each outfall and must meet the standards set under the various industrial point source categories.
	TCE was specifically designated as 1 of 65 priority toxic pollutants or pollutant categories. TCE is therefore regulated for a number of specified industrial point source categories.
Resource Conservation and Recovery Act (RCRA):	RCRA specifies that any solid waste containing TCE is a hazardous waste. In addition, TCE is considered hazardous under RCRA as spent halogenated solvent (F001, F002).
	Hazardous wastes under RCRA are subject to the "cradle-to-grave" manifest system that covers generators, transportation, storage, and disposal of such wastes.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	Reportable quantity of 1,000 lbs (same as Clean Water) constitutes a hazardous spill.
Occupational Safety and Health Act:	Average exposure limit, set June 27, 1974, is 100 ppm, with an acceptable maximum of 200 ppm.
Federal Food, Drug, and Cosmetic Act:	Establishes tolerances for residues of TCE in certain foods as a result of its use as a solvent in their manufacture.
Hazardous Materials Transportation Act:	Has established rules governing transportation of hazardous materials, including TCE.

SOURCE: Office of Technology Assessment, 1986.

life of TCE in surface water is estimated to be a few hours to a few days, depending on the characteristics of the body of water. TCE is also known to volatilize from soil; rate estimates are imprecise but suggest that volatilization from soil occurs at about an order of magnitude than volatilization from water at a similar depth.[39] The fate of TCE is usually destruction by photooxidation following direct emission to air or volatilization from water or soil. The half-life for this process is estimated to be 24 to 48 hours.

Although TCE was not thought to undergo any other significant breakdown reactions, it is now thought that TCE trapped in groundwater does degrade, with a half-life of about a year. EPA recently concluded that available data supports the hypothesis that the major source of groundwater contamination by vinyl chloride, 1,2-dichloroethylene, and 1,1-dichloroethylene is the decomposition of TCE and tetrachloroethylene.[40] Since TCE is widely released in the environment, EPA also expects its degradation products to have a wide occurrence. TCE is the most common hazardous substance at Superfund sites.[41]

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[39] Arthur D. Little, Inc., and Acruex Corp., op. cit.

[40] 50 Federal Register 46880, Nov. 13, 1985.

[41] U.S. Environmental Protection Agency, Office of Emergency and Remedial Response, "Supporting Analysis for CERCLA Section 301(a)(1)(c) Study," draft report, Task No. 7, EPA contract 68-01-6872, July 1984, Exhibit 1, p. 3-5.

Data Used for Legislation and Regulations

In general, regulatory action is supported by some amount of: 1) health effects data; 2) exposure data, often in the form of environmental release data; and 3) health risk assessment data, which is based on the first two.

EPA's most recent action regarding TCE was its notice of intent to list it as a hazardous air pollutant under Section 112 of the Clean Air Act.[42] Although this action can be based on less information than that required for a full regulation, the type and amount of data on which this action is based is of interest because: 1) it is one of EPA's most recent actions involving TCE and thus is based on the most current data; and 2) it is probably similar to the type, amount, and quality of data currently available to Congress or EPA if either were to take action on waste reduction for TCE.

Most of the data used by EPA were health effects data, however, the notice makes it clear that EPA felt much of the information about carginogenic effects of TCE on humans was unreliable. It considered only two studies with animals to be sufficiently valid to provide a basis for classifying TCE as a probable human carcinogen.

EPA's TCE exposure and cancer risk analysis used EPA's Human Exposure model to estimate public exposure to TCE from TCE source categories described in EPA's *Survey of Trichloroethylene Emissions Sources*. However, EPA admits that the source and environmental release information used in the risk estimates is very rough and plans to improve these data before proceeding further with the listing procedures.

Despite the fact that EPA relied on very recent data in its deliberations about whether to list TCE as a hazardous air pollutant, it is clear from this brief overview that:

- EPA concluded that in most areas it had insufficient data to promulgate a regulation at this time.
- Most of the data EPA uses and plans to collect to support this regulation are health effects and public exposure data, both of which are only peripherally related to waste reduction.
- Much of the information EPA plans to collect will be sampling data to support modeling of exposure and dispersion. Such information will be only marginally relevant to waste reduction

National Materials Balance

There were two early separate attempts at a materials balance for TCE.[43] Both of these are rather old now; they used 1977-78 data. The Level I materials balance draws on a wide variety of readily available public documents and personal communications with producers and users of TCE.[44] More recent data (1983-84) have been collected in other studies, but these are less comprehensive and do not specifically attempt a materials balance.

One of the most useful sources of information compiled about TCE is EPA's *Survey of Trichloroethylene Emissions Sources* (STES).[45] To supplement background information available in public documents and other published literature, EPA used its authority under Section 114 of the Clean Air Act to request data on TCE sources, production/sales, emissions, and emissions control techniques from the two identified producers of TCE and 13 of the 16 identified producers or users of TCE as a byproduct in operations.

There are a number of limitations on these data. First, companies were asked only to provide *estimates* of these figures, not to measure emissions. Emissions from equipment leaks and storage tanks, for example, were calculated using modeling equations. Second, and more important, the 15 plants from which EPA was able to gather plant-specific data only account for approximately 128 metric tons of the estimated 57,600 metric tons of TCE emitted in 1983.[46] EPA was unable to gather data from specific sites for metal degreasing operations for the STES report. These are estimated to account for 85 percent of TCE use and about 91 percent of total TCE emissions. An attempt was made to compensate for this enormous gap using gross estimates of the amount of TCE emitted in five industries that use TCE in degreasing operations.[47] These estimates were obtained by applying emissions factors generated from available literature to 1983 consumption data for each of the five industries.[48]

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[42] 50 Federal Register 52422, Dec. 23, 1985, amended at 51 Federal Register 7714, Mar. 5, 1986. Specific documents relied on are listed in the Notice.

[43] JRB Associates, Inc., "Level I Materials Balance: Trichloroethylene," op. cit. Also, JRB Associates, Inc., "Materials Balance—Task #14: Chlorinated Solvents," final draft contractor report prepared for EPA's Office of Pesticides and Toxic Substances, Survey and Analysis Division, July 11, 1980.

[44] Compare this with the Level II materials balance attempted for cadmium which was much more ambitious in scope.

[45] U.S. Environmental Protection Agency, *Survey of Trichloroethylene Emissions Sources*, EPA-450/3-85-021 (Washington, DC: Office of Air Quality Planning and Standards, July 1985).

EPA has published estimates of the distribution of TCE emissions in environmental media shown in table 4-7. Although TCE emissions can be controlled through carbon traps and/or condensers, almost all TCE in use is eventually emitted into the air because recycled solvent is reused and landfilled still bottoms lose residual TCE via volatilization.

Table 4-7.—Release of TCE Into the Environment (metric tons per year for 1978)

Source	Air	Land	Water
Production	300	—	40
Metal degreasing	92,400	12,800	2,200
Other solvent uses	11,400	1,600	270
PVC chain terminator	130	—	—
Total	104,230	14,400	2,510
Percent of total	(86%)	(12%)	(2%)

SOURCE: U.S. Environmental Protection Agency, *Intermedia Priority Pollutant Guidance Document: Chlorinated Solvents*, July 1982, revised October 1984.

Plant, Company, and Industry-Level Information

OTA was able to find some small amount of plant level data on TCE for the 15 producers and users surveyed by EPA under Section 114 (see above), although the production/sales data for these plants were confidential. In addition, a materials balance for TCE in the electronics industry has been done. But less than 1 percent of the total use of TCE is accounted for in the electronics industry which has now turned to TCE substitutes in most cases for occupational safety reasons.[49]

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[46] See table 4-7, below.

[47] These five industries are: furniture and fixtures, fabricated metal products, electrical and electronic equipment, transportation equipment, and miscellaneous manufacturing industries.

[48] EPA estimated that for every kilogram of fresh TCE used in degreasing, 94 percent is directly volatilized during the degreasing process.

[49] PEI Associates, Inc., "Occupational Exposure and Environmental Release Assessment of Four Chlorinated Solvents When Used in the Electronics Industry," draft contractor report prepared for the U.S. Environmental Protection Agency, Jan. 10, 1985.

Chapter 5

Waste Reduction in the Federal Government

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Chapter 5

Waste Reduction in the Federal Government

INTRODUCTION

The implementation of a voluntary, yet regulatory *waste minimization* program under the Environmental Protection Agency's (EPA's) Office of Solid Waste is a consequence of amendments that were passed by Congress in 1984 to the Resource Conservation and Recovery Act (RCRA). Throughout the discussion of current government and industry activities in this report, OTA has attempted to show how *waste minimization*, as it is evolving, is not necessarily *waste reduction*. In fact, **focus on waste minimization can shift attention away from waste reduction.**

RCRA and the other national environmental protection legislation and programs of the last 15 years have been based on *pollution control*. Implementing waste reduction, a concept of environmental protection that emphasizes *pollution prevention*, may require both a new legislative mandate and a new administrative effort. Significant difficulties could also arise in the implementation of waste reduction if the concept is strictly confined to those hazardous wastes covered by RCRA.

The first section of this chapter discusses these aspects of waste reduction, starting with an examination of the evolution of a pollution control culture under the existing media environmental programs and a discussion of the problems this traditional approach represents for the adoption of effective waste reduction. This chapter then reviews the portions of the 1984 RCRA Amendments that are the basis for the waste minimization regulations now in effect and analyzes possible outcomes of the resultant voluntary program in terms of waste reduction.

The last section covers supplemental activities (e.g., research and development and technology and information transfer services) in the Federal Government that may be of assistance to companies and State and local governments that are attempting to shift from pollution control (or, waste management) to pollution prevention. These services are scattered throughout the Federal Government and are not always identified as waste reduction. A separate waste reduction program could provide coordination to pull these services into focus to enhance their benefit.

BUILDING TOWARD A WASTE REDUCTION ETHIC

The current national environmental statutes and programs implemented by EPA constitute a *waste managemeni by media* approach to environmental protection. Pollutants are deposited into the Nation's air, water, and land as an end result of activities such as manufacturing and transportation. The strategy employed to protect the environment has invariably been to try to affect that disposal by controlling those pollutants, individually by media, *after* they have been produced and have the potential to move among media.

During the first 15 years of Federal environmental protection, this strategy of waste management by media has supported and enhanced the growth of a *pollution control culture*. **Policymakers, regulators, industry, engineers, and environmentalists have become accustomed to thinking solely in terms of waste management.** While economics and health issues and national goals in competition with public health and the environment play a variable part, the standards developed under the environmental programs are primarily based on an analysis of the technical capabilities for controlling those substances that are produced. Little parallel consideration has been given to pollution prevention by assessing and altering the activities that create the pollutants. Despite an increasing interest in waste reduction today, pollution control still appears to be the path of least resistance in environmental protection.

The Evolution of the Pollution Control Culture

The concept of pollution prevention was added to RCRA with the 1984 amendments on waste minimization. Waste reduction, however, is not a new idea. Neither is recognition of the cross-media transfer of pollutants.

Pollution prevention has been a part of the Clean Air and Clean Water Acts since the early 1970s. While pollution control is given priority in these acts in the setting and application of air and water regulations, each allows for the use of alternative approaches. Each makes explicit statements equating environmental protection with pollution control *and* prevention. The first goal of the Clean Water Act, to eliminate the discharge of pollutants, is only physically possible if pollutants are eliminated at the source (i.e., by waste reduction). In setting effluent guidelines, the act allows the use of "process and procedure innovations, operating methods, and other alternatives."[1] Title I of the Clean Air Act, which covers regulations for industrial sources, is named Air Pollution Prevention and Control. Throughout, the phrase *prevention and control* is repeatedly used. In setting regulations based on air quality criteria, the act in many places allows waste reduction options.[2]

Despite the seeming flexibility of these statutes, pollution prevention has not often been pursued. The more obvious path has proven to be pollution control. Pollution control is easier to pursue because it tends to use generic technology: wastewater treatment; scrubbers, electrostatic precipitators, and baghouses; cement walls; and steel drums. All must be adapted in varying degrees to each particular process that produces the pollutants but scientific principals and operations are well understood and outcomes can be reliably predicted. Pollution control is also easier because it does not involve penetrating into the confidentiality of or disrupting industry processes. Nor does it threaten product quality. Although regulations rarely require the adoption of specific technology, it is often simpler for a firm to adopt the control technology used to set regulations than to devise alternative methods.

Pollution Control's Beginnings

Legislative activity of the 1970s and the comprehensive assumption of Federal responsibility for environmental protection was a result of pollution problems that were identified in the 1960s. The immediate environmental crisis needing solution was an accumulation of problems that had been created in the past. The Nation's water was polluted, the air was dirty, and the land was overburdened with trash. Recognition of this crisis instilled a point of view that has persisted since: a perspective on pollution that focuses on its place of disposal or point of release. Since those early years, extensive measures have been taken to solve the problems created by pollutants; few have been taken to address the creation of pollutants. Wastewater treatment, a known civil engineering technology, quickly became the major clean water technology in the 1970s. Similarly, familiar techniques such as building walls as barriers were initially adopted for the Superfund cleanup program in the 1980s.

It is illuminating to note that in 1970, *before* major environmental legislation was passed, the first report of the Council on Environmental Quality included the following statement about the complexity of environmental problems and inadequacy of the pollution control approach:

> . . . the sources of air, water, and land pollution are interrelated and often interchangeable. A single source may pollute the air with smoke and chemicals, the land with solid wastes, and a river or lake with chemical and other wastes. Control of air pollution may produce more solid waste, which then pollute the

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[1] Clean Water Act, Section 301(b)(2)(A).

[2] The waste reduction aspects of the individual environmental statutes are analyzed more fully later in this chapter.

> land or water. Control of the water-polluting effluent may convert it into solid wastes, which must be disposed of on land.[3]

The suggested solution was to have: "A far more effective approach to pollution control."[4] It was thought that this could be gained through the coordination of media problems that would come about with the organization of the Environmental Protection Agency.

The 1970 report makes little specific mention of pollution prevention. It analyzes water and air pollution, solid wastes, and pesticide use and presents a series of recommendations for each. Only in the discussions of water quality and pesticides does pollution prevention appear. Often prevention is mentioned within the context of research needs. For instance:

> Water pollution, like other forms of pollution, is a problem of materials balance . . . Attention must be given to technology assessment to prevent future pollution and to choose alternative courses that will reduce it.[5]

The situation was very different in the case of pesticide problems, where pollution prevention was a major finding. Proposals for more effective regulation included measures to assure adoption of less persistent or less toxic materials and to limit the availability of certain types of pesticides.

Pollution Control and Cross-Media Shifts

Despite recognition that the environment must be perceived as a single, interrelated system, EPA was organized by individual media rather than by functions.[6] The discussion about a need for a multimedia focus continues today.[7]

The current division among media is not always distinct. The Clean Air Act authorizes programs that deal with air emissions. Water as a medium is covered by three statutes: the Clean Water Act (discharges into U.S. waters), the Marine Sanctuaries Act (protection of coastal and ocean waters), and the Safe Drinking Water Act (sources of drinking water). The Resource Conservation and Recovery Act is generally understood to deal with the medium of land, but while it sets standards for land disposal of hazardous wastes—primarily to protect groundwater—it also does so for incineration, which inevitably involves air emissions. The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) also deals with land issues through its controls on the use of pesticides. The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) provides for the cleanup of polluted land and underground water resources. The Toxic Substances Control Act (TSCA), like FIFRA, focuses on chemical substances, the use of which can affect all media.

Pollutants are released into the environment as solids, liquids, or gases and do not follow paths set forth by statute. Once released their physical or chemical forms can change, and they can be transported some distance from their source by air or by water. The effect of environmental regulations and their implementation is often to shift pollutants among media—in some cases out of the realm of regulatory control. For example: both wastewater treatment plants and air pollution control devices produce a sludge which can be a hazardous waste and may or may not be regulated under RCRA; tall smokestacks required under clean air regulations to disperse emissions long distances are now suspected of being a source of acid rain; surface impoundments (settling ponds), for which RCRA sets operating standards, are a source of volatile organic compound (VOC) air emissions.

Shifting is not in itself an inherently bad practice. The impact of any particular form of a hazardous substance can vary with its presence in different environmental media. But determination of risk must be made individually, including analyses of how the pathway will increase or decrease the potential for harm to human health or the environment. While shifting may solve a problem in one medium, it can create a problem in another. Prudence and limited resources with which to make determinations of risk would dictate that shifts be avoided whenever possible.

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[3] Council on Environmental Quality, *Environmental Quality 1970*, "Appendix H: Message of the President Relative to Reorganization Plans Nos. 3 and 4 of 1970, July 9, 1970," p. 295.

[4] Ibid., p. 295.

[5] Ibid., p. 59.

[6] See Alfred Marcus, "Environmental Protection Agency," *The Politics of Regulation*, James Q. Wilson (ed.) (New York: Basic Books, 1980).

[7] See The Conservation Foundation, *Controlling Cross-Media Pollutants* (Washington, DC: 1984); and Barry G. Rabe, *Fragmentation and Integration in State Environmental Management* (Washington, DC: The Conservation Foundation, 1986). Also, Christine Mlot, "Multimedia Maneuvers," *Science News*, Feb. 23, 1985; Rochelle L. Stanfield, "Pollutants That Just Won't Go Away Pose Challenge for EPA and States," *National Journal*, Dec. 8, 1984.

Shifts among media are possible and legally sanctioned because the environmental statutes differ from one another in a number of critical respects. They are inconsistent in the substances covered and in the way in which they are to be analyzed and regulated. Some statutes require that the economic impacts of regulations be considered; others do not. The rigorousness with which scientific evidence must be applied to the analysis of risk to human health and/or the environment differs among statutes. Even the language used in statutes and adopted in common use varies, as shown in table 5-1. Some definitions are specifically given by statute; others are set forth by regulation.

The regulatory philosophy of both the Clean Air and the Clean Water Acts has been to limit the amount of designated chemicals, compounds, or classes of chemicals released into the Nation's air and water. Regulated substances can still be produced and do not have to be destroyed. Both programs legally sanction industrial releases below permitted limits. The list of regulated chemicals and/or industries (sources) has never been the same for both water and air, allowing shifts between these media.

Hazardous wastes classified under RCRA have not been regulated in the same way as water and air pollutants. RCRA does not limit releases; it sets standards for the management (treatment, storage, and disposal) of whatever is produced. RCRA regulations apply to all industrial categories but unequally depending on the amount generated. The body of substances defined as RCRA hazardous wastes has always been much larger than those regulated either as air or water pollutants. Many RCRA hazardous wastes are not regulated under the Clean Air or Clean Water Acts as air or water pollutants although they can be the same chemical or compound. Therefore, if it is technically possible and economically beneficial, a regulated RCRA hazardous waste can be legally emitted into the air or water. Also, chemicals that are limited in terms of disposal by air and water regulations can be managed in unlimited amounts as RCRA hazardous wastes. These provisions create perfectly legal opportunities for shifts between RCRA (i.e., land disposal) and the air and water.

Growing evidence that the RCRA management practices for land disposal were failing to protect health and the environment is forcing a change in the RCRA system. The 1984 RCRA Amendments mandated EPA to impose a series of land disposal *bans* based on chemical classes. So far, EPA's approach toward setting these regulations has been based on the earlier water and air philosophy. Limits are being proposed for *permissible* water-borne releases from land disposal facilities.

The Pollutional Control System

The pollution control culture was graphically summed up in 1985 by the Administrator of EPA, Lee M. Thomas, who said:

> The current statutory structure arises from a general environmental strategy that has been accepted—consciously or not—by nearly everyone who has worked for environmental protection in this country. Let's call it the strategy of the cork.
>
> It consists of putting a regulatory cork in every pollution source you can find as quickly as you can. At first the corks may be somewhat loose and some pollution escapes. But with advances in technology they can be pushed in tighter. Of course, as we have seen, the pollution will tend to squirt out in new and unexpected places. The solution is a new set of corks, and the process of jamming them in begins all over again. The idea is that if you get enough corks, and put enough pressure behind them, pollution will eventually be eliminated.[8]

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[8] Lee M. Thomas, "A Systems Approach: Challenge for EPA," *EPA Journal*, September 1985, p. 22.

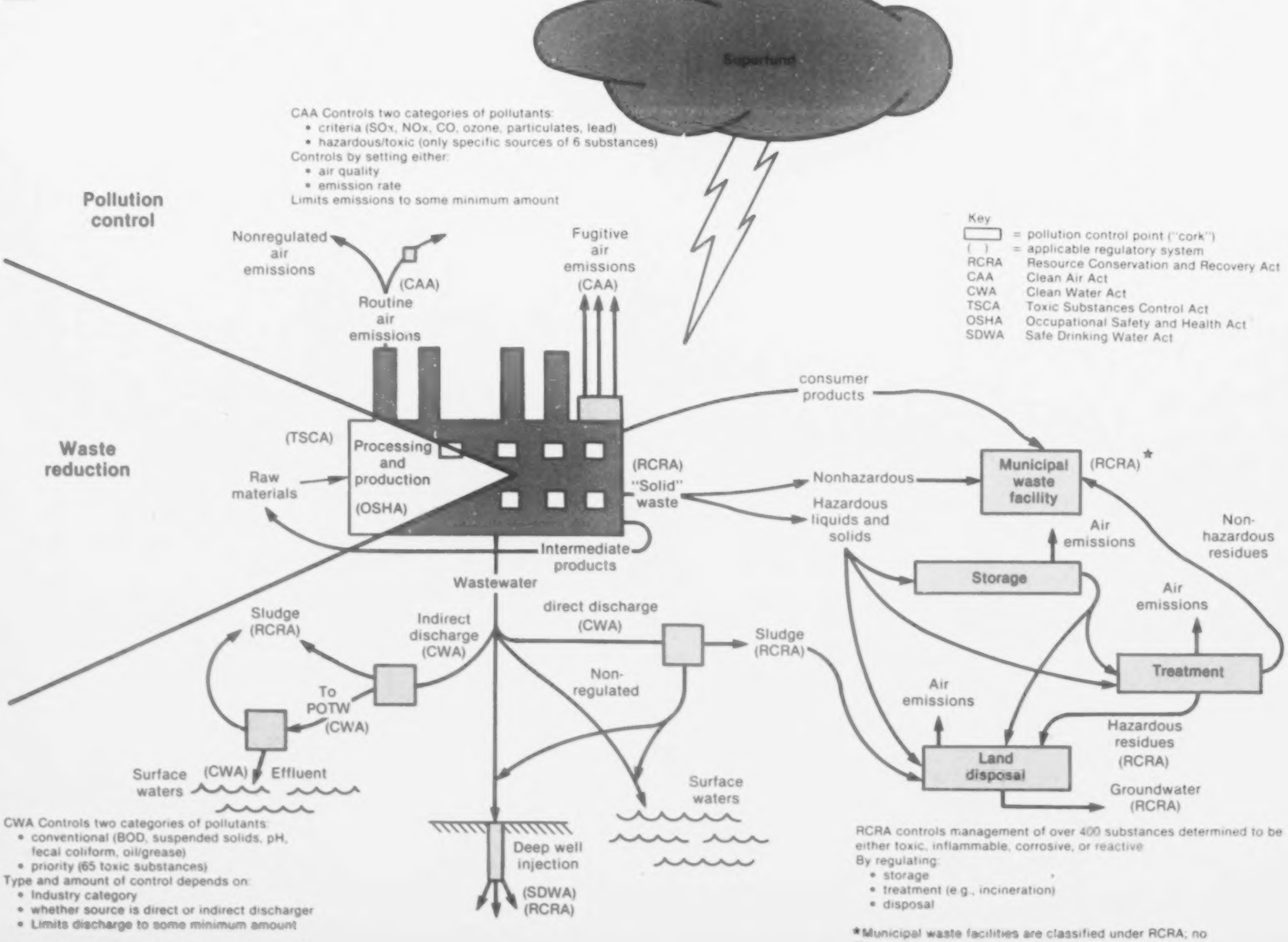
Table 5-1.—Statutory Definitions of Hazardous Waste Terms

Terms by program	Statutory definition	Notes
Clean Water:		
Conventional pollutants . . .	. . . including but not limited to pollutants classified as biological oxygen demanding, suspended solids, fecal coliform, and pH. [Section 304(a)(4)]	List appears in 40 CRF 401.16; with oil and grease added
Toxic pollutants	. . . those pollutants, or combinations of pollutants, including disease-causing agents, which after discharge . . . will, on the basis of information available to the Administrator, cause death, disease, behavioral abnormalities, cancer, genetic mutations, physiological malfunctions (including malfunctions in reproduction) or physical deformations, in . . . organisms or their offspring. [Section 502(13)]	
	Table 1 of Committee Print 95-30 of the Committee on Public Works and Transportation of the House of Representatives . . . to be published by Administrator. . . Revisions to list must take into account toxicity of pollutant, persistence, degradability, usual or potential presence of affected organisms in any waters and their importance, and nature and extent of effect on organisms. [Section 307(a)(1)]	List of 65 substances appears in 40 CRF 401.15 Commonly referred to as "priority" pollutants
Hazardous substances	. . . such elements and compounds which, when discharged in any quantity into or upon the navigable waters of the United States . . . present an imminent and substantial danger to the public health and welfare, including, but not limited to fish, . . . [Section 311(b)(2)(A)]	A list of hazardous substances as identified by the regulatory system appears in 40 CFR 116.4
Clean Air:		
Air pollutants	. . . emissions which, in his [the Administrator's] judgment, cause or contribute to air pollution which may reasonably be anticipated to endanger public health or welfare . . . [Section 108(a)(1)(A)]	Often referred to as "criteria" pollutants because of the air quality criteria document that must be issued prior to regulation
Hazardous air pollutants . . .	An air pollutant to which no ambient air quality standard is applicable and which in the judgment of the Administrator may cause, or contribute to, an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness [Section 112(a)(1)]	Commonly referred to as "toxic" air pollutants
RCRA:		
Hazardous waste	. . . any solid waste, or combination, which because of its quantity, concentration, or physical, chemical, or infectious characteristics may (A) cause or significantly contribute to an increase in mortality or an increase in serious irreversible, or incapacitating reversible, illness; or (B) pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, transported, or disposed of, or otherwise managed. [Section 1004(5)]	List of reportable quantities of hazardous substances is in 40 CFR 261
CERCLA:		
Hazardous substances	. . . (A) any substances designated . . . [by] Section 31(b)(2)(A) of the Federal Water Pollution Control Act, (B) any element, compound, mixture, solution, or substance designated pursuant to section 102 of this Act, (C) any hazardous waste . . . [regulated under] Section 3001 of Solid Waste Disposal Act . . . (D) any toxic pollutant listed under Section 307(a) of Federal Water Pollution Control Act, (E) any hazardous air pollutant listed under Section 112 of the Clean Air Act, and (F) any imminently hazardous chemical substance or mixture . . . [listed under] Section 7 of TSCA. [Section 101(14)]	List of reportable quantities of hazardous substances is in 40 CFR 302
TSCA:		
Chemical substances and mixtures	. . . any organic or inorganic substance of a particular molecular density . . . (not excluded by subparagraph B) [Section 3(2)(A)]	To regulate, must make a finding of "unreasonable risk of injury to health or the environment"

SOURCE: Compiled by the Office of Technology Assessment, 1986, from environmental statutes and 40 CFR.

Figure 5-1 shows a hypothetical industrial plant with its "regulatory corks" in place, releases that are either legally sanctioned or not regulated, and cross-media shifts of pollutants. As the figure shows, the pollution control side of the plant is a complex maze. The application of waste reduction can reduce that complexity.

Figure 5-1.—Waste Reduction v. Pollution Control


Superfund
Pollution control
Waste reduction
Nonregulated air emissions
(CAA)
Routine air emissions
Fugitive air emissions (CAA)
(TSCA)
Raw materials
Processing and production
(OSHA)
(RCRA)
"Solid" waste
Intermediate products
consumer products
Nonhazardous
Hazardous liquids and solids
Municipal waste facility
(RCRA)*
Air emissions
Storage
Non-hazardous residues
Air emissions
Treatment
Air emissions
Hazardous residues (RCRA)
Land disposal
Groundwater (RCRA)
Wastewater
Indirect discharge (CWA)
direct discharge (CWA)
Sludge (RCRA)
Sludge (RCRA)
To POTW (CWA)
Non-regulated
Surface waters
(CWA)
Effluent
Surface waters
Deep well injection
(SDWA) (RCRA)

CAA Controls two categories of pollutants:
- criteria (SOx, NOx, CO, ozone, particulates, lead)
- hazardous/toxic (only specific sources of 6 substances)

Controls by setting either:
- air quality
- emission rate

Limits emissions to some minimum amount

Key

▭	= pollution control point ("cork")
( )	= applicable regulatory system
RCRA	Resource Conservation and Recovery Act
CAA	Clean Air Act
CWA	Clean Water Act
TSCA	Toxic Substances Control Act
OSHA	Occupational Safety and Health Act
SDWA	Safe Drinking Water Act

CWA Controls two categories of pollutants:
- conventional (BOD, suspended solids, pH, fecal coliform, oil/grease)
- priority (65 toxic substances)

Type and amount of control depends on:
- Industry category
- whether source is direct or indirect discharger
- Limits discharge to some minimum amount

RCRA controls management of over 400 substances determined to be either toxic, inflammable, corrosive, or reactive
By regulating:
- storage
- treatment (e.g., incineration)
- disposal

*Municipal waste facilities are classified under RCRA; no Federal regulations/standards apply.

SOURCE: Office of Technology Assessment.

Environmental Protection Under the Pollution Control Culture

The dominance of pollution control in protecting the environment begs the question of effectiveness. Most people would agree that improvements have been made in the areas of conventional air and water pollutants and that high uncertainty exists in terms of unregulated and toxic substances.

The General Accounting Office in 1982 asked the question, "What have we accomplished?" It replied:

> Overall, there has been progress toward meeting established goals. The air is significantly cleaner, more wastewater now receives the required level of treatment, and most drinking water meets national standards. The job, however, is still far from complete.[9]

The Conservation Foundation reported in 1984 that since 1982:

> Air quality has continued to improve . . . Water quality, on balance, has remained constant, as has been true for the past decade. As with air, this finding is based on the traditional measure of pollution and does not take into account pollution from toxic substances. There are simply not enough monitoring data to know whether the toxics problem is getting better or worse.[10]

Statutes are only as good as the regulations that follow. Once set, regulations must be complied with to be effective. Effective compliance depends on whether control devices have the technological capability to operate efficiently and routinely over time. Considerable time often separates the enactment of a statute and the promulgation of regulations.[11] Reasons commonly cited for this are: administrative delays, the technological complexity of setting regulations, the inadequate scientific base now available with which to determine health risks, and lawsuits that have been brought by both regulated industries and affected communities. Compliance with regulations is based on an analysis of the risk, by those being regulated, of not complying. This risk increases as the perceived level of enforcement activity increases. The compliance rate will also be proportional to the penalty for noncompliance.

Analysis of regulatory effectiveness for policymakers at the Federal level is complicated by a paucity of data. On a national basis, data are available that show the trends over time in the emissions of conventional air pollutants. Similar data are not available for hazardous air pollutants, conventional or toxic water pollutants, or RCRA hazardous wastes.[12] This is so despite the fact that environmental regulations impose innumerable reporting and recordkeeping requirements on industry (see ch. 4).

Air Quality

Conventional air pollutant data is obtained from continuous monitoring equipment operated by State and local governments and various Federal agencies. Some 250 million air pollution measurements are included in EPA's National Aerometric Data Bank,[13] and this information is compiled and published annually. The compilation published in 1986 shows that in 1984 emissions totaled 184 million metric tons. Total suspended particulates were 7 million metric tons; sulfur dioxides, 20 million metric tons; carbon monoxide, 75 metric million tons; nitrogen dioxides, 20 million metric tons; and volatile organic compounds (VOCs), 22 million metric tons. Over the period 1975-84, emissions of these pollutants decreased from between 6 and 33 percent. Lead emissions, recorded at 40 million tons per year in 1984, have declined 72 percent over the same period. In the report this dramatic decline is attributed primarily to the lowering of lead content in gasoline and the introduction of unleaded gasoline. Both of these are waste reduction, rather than pollution control measures.

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[9] U.S. Congress, General Accounting Office, *Cleaning Up The Environment: Progress Achieved But Major Unresolved Issues Remain*, GAO/CED-82-72 (Gaithersburg, MD: July 21, 1982), p. i.

[10] The Conservation Foundation, *State of the Environment: Assessment at Mid-Decade* (Washington, DC: 1984), p. 9.

[11] For instance, while the statute was enacted in 1972, pretreatment standards for indirect water discharges are still not complete. Standards have been set for only six hazardous air pollutants after 15 years.

[12] For an overview of national environmental monitoring, see Rochelle L. Stanfield, "No One Knows for Sure if Pollution Control Programs Are Really Working," *National Journal*, Mar. 23, 1985, pp. 643-646.

[13] U.S. Environmental Protection Agency, *National Air Quality and Emissions Trends Report, 1984*, EPA-450/4-84-001 (Research Triangle Park, NC: Office of Air Quality Planning and Standards, April 1986), p. 16.

No national data exist for emissions of specific hazardous air pollutants; there is no regular monitoring program. No time series data are available for these pollutants. The data that do exist are arrived at by such techniques as taking grab samples at specific locations and extrapolating the data received to the national level. Separate EPA estimates of annual releases of hazardous air pollutants give different results because methodologies and substances included vary. A study on control techniques for VOCs estimated annual emissions from industrial sources at 24.7 million metric tons.[14] Another report that attempted to pool available nationwide data on just 86 hazardous air pollutants estimated these emissions to be about 4.5 million metric tons per year.[15]

RCRA Hazardous Wastes

OTA, in its 1983 report *Technologies and Management Strategies for Hazardous Waste Control*,[16] said that about 255 to 275 million metric tons of hazardous waste under Federal and State regulation are generated annually. A national survey on the generation of RCRA hazardous wastes was released by EPA in 1984. It estimated that 264 million metric tons were generated in 1981.[17] No national trend data are available for this universe of pollutants. The Chemical Manufacturers Association has surveyed its members for the last 4 years but only 324 chemical plants have responded in all 4 years. In the 1984 survey, 725 plants reported generating 253 million metric tons of hazardous waste.[18]

Water Quality

The only national data on conventional and toxic water pollutants are models that predict the outcome of different levels of effluent limitations and compilations of permits that have been issued. These data do not show what is being discharged but only what industries have been permitted to discharge. Permit holders are required to monitor their actual discharges and submit Discharge Monitoring Reports regularly to EPA Regional Offices or State offices. The Regional Offices are responsible for the management of the monitoring data but they are generally years behind in doing so. The data are not systematically aggregated into national statistics.

The above discussion shows that national data is so disparate that it can only be used to provide a sense of the magnitude of multimedia pollutant releases. In addition, the data—by itself—indicates little about the consequences of discharges to public health and the environment.

Waste Reduction: Multimedia Pollution Prevention

The importance of waste reduction to environmental protection has been acknowledged in the national policy statement of RCRA which states: " . . . the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible." As OTA has shown throughout this report, however, **the primacy given to this concept over waste management is already being diluted by the various ways in which the regulatory term waste minimization is being individually defined and carried out under current regulations.**

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[14] U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, "Control Techniques for Volatile Organic Compound Emissions From Stationary Sources," draft report, July 1985.

[15] Tom Lahre, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, "Characterization of Available Nationwide Air Toxics Emissions Data," June 13, 1984. The report discusses the difficulties of aggregating such data and their reliability.

[16] U.S. Congress, Office of Technology Assessment, *Technologies and Management Strategies for Hazardous Waste Control*, OTA-M-196 (Washington, DC: U.S. Government Printing Office, March 1983).

[17] U.S. Environmental Protection Agency, *National Survey of Hazardous Waste Generators and Treatment, Storage and Disposal Facilities Regulated Under RCRA in 1981*, EPA 530/SW-84-005 (Washington, DC: Office of Solid Waste and Emergency Response, April 1984), p. 2.

[18] Chemical Manufacturers Association, "Results of the 1984 CMA Hazardous Waste Survey," January 1986.

In short, although the concept of waste reducton is officially sanctioned, it is already being overwhelmed by the pollution control culture. To counter what appears to be an inevitable trend, waste reduction requires leadership and visibility. Neither is being provided yet by the Office of Solid Waste (OSW) at EPA where the responsibility for waste minimization now lies. There, the focus is solely on waste management, on avoiding the land disposal of RCRA hazardous wastes. Waste minimization has become one of several tools to achieve that goal rather than a goal itself. When asked about the significance of the 1984 amendments to the Resource Conservation and Recovery Act, the director of OSW said: " . . . it really makes it crystal clear that Congress wants the Agency to move away from land disposal to *other forms of disposal*."[19]

Government spending on waste reduction reflects the general lack of priority for pollution prevention. As table 5-2 shows, government spent almost $16 billion in 1984 on pollution control. OTA estimates that government spending on waste reduction totaled only $4 million in fiscal year 1986. This amount will more than double if Congress approves the Department of Defense's request for $30 million in fiscal year 1987 for its new waste minimization plan. (An estimated 20 percent of that budget may go toward waste reduction.) Even then, overall spending on waste reduction will be less than 1 percent of that spent for pollution control.

Implementing a goal of pollution prevention (i.e., waste reduction) may only be possible when responsibility lies outside the existing media programs. A waste reduction program, especially one based on a nonregulatory approach,[20] need not rival the size and cost of the current regulatory media programs. Along with its own legislative mandate, provisions and resources of the existing programs could be used to implement a waste reduction program. **Within either a regulatory or nonregulatory format, a separate waste reduction program could provide the basis for a shift from pollution control to pollution prevention. A separate waste reduc-**

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[19] "Making the New RCRA Work: An Interview with Marcia Williams," *EPA Journal*, April 1986, p. 3. Italics for emphasis.

[20] The pros and cons of a regulatory vs. a nonregulatory program are presented in ch. 2 of this report. Also, in ch. 6, waste reduction activities at the State level which are predominantly nonregulatory are discussed.

Table 5-2.—Government Spending on Pollution Control v. Waste Reduction
(millions of dollars)

Type and source of spending	Total budget	Estimated percent for waste reduction	Annual expenditures
A. Pollution control[a]			
Pollution abatement			$12,275
Regulation, monitoring, and R&D			3,443
Total			$15,718
B. Waste reduction[b]			
Federal Government:			
EPA			$0.8
Report to Congress (WM)	$0.550	× 50 = $0.175	
ORD WM R&D	0.235	× 10 = 0.02	
R&D HW grants	1.0	× 50 = 0.5	
DOD waste minimization program	5.0	× 20 =	1.0
TVA waste managment	2.0	× 5 =	0.1
State governments:[c]			
Based on 10 existing programs	7.0	× 25 =	1.8
Total			$3.7

[a] Federal, State, and local data for 1984. Department of Commerce news release, Aug. 5, 1986.
[b] OTA estimate for fiscal year 1986.
[c] Some State program funds are provided by EPA.
KEY: WR = waste reduction, WM = waste minimization, and HW = hazardous waste.

SOURCE: As noted.

tion program could also serve as an instrument to make the multimedia approach a priority within EPA.

Actions that generate air and water pollutants can be as amenable to waste reduction as are those producing RCRA hazardous wastes. However, with statutory authority covering only RCRA hazardous wastes, there is little reason to believe that industry or EPA will move beyond the regulations and consider air and water pollutants in their waste minimization programs.[21] While most State waste reduction programs focus on RCRA hazardous wastes, a few have taken a multimedia approach (see ch. 6).

Given this concentration on only one of the three regulated waste streams generated by industry and the inconsistencies that exist between the substances covered and the methods of regulation under RCRA and the clean air and clean water programs, *the current waste minimization program might actually contribute to an increase in air and water pollution.*

Waste reduction, however, cannot by itself prevent all of the Nation's environmental problems. Some amount of hazardous wastes will always be generated. Some wastes will require land disposal because they cannot be recycled or completely destroyed. Some will be emitted unavoidably into the air and released into the water. Thus, it is important that the current pollution control regulatory system be held in place and its effectiveness increased through stronger enforcement activities. In the absence of prescriptive waste reduction regulations, the pollution control regulations become indirect incentives that encourage some in the private sector to adopt waste reduction.

The effective operation of a waste reduction program can also be hampered by existing statutes and regulations. The sanctioned, permitted release of pollutants under the air and water programs creates a problem for the measurement of waste reduction and may eliminate some of the incentive. Does waste reduction occur, for instance, when an existing raw (untreated) pollutant stream is reduced while the discharge or emission remains the same as it was because the standards legally sanction the rate of release? Any change in the outflow may cause a plant to become involved in permit revisions. A plant that makes a significant change may become subject to stiffer water or air regulations. Thus, current environmental protection statutes may be barriers to pollution prevention since no firm willingly adopts practices that will cause it to make costly revisions in its regulatory status.

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[21] For instance, few of the industry documents that OTA has obtained describing corporate waste minimization plans go beyond RCRA hazardous wastes; some explicitly exclude air and water regulated wastes from their plans. Most of the waste reduction case histories now published focus on RCRA hazardous wastes.

WASTE MINIMIZATION: STATUTE AND REGULATIONS

The Hazardous and Solid Waste Amendments of 1984 set new national policy about the generation of hazardous waste. This policy and the waste minimization provisions that amended the Resource Conservation and Recovery Act (RCRA) now serve as the basis for Federal action to reduce the generation of hazardous waste.[22]

The Statute

Under Section 1003 of RCRA, "Objectives" was retitled "Objectives and National Policy" and a new paragraph stated succinctly:

> The Congress hereby declares it to be the national policy of the United States that, wherever feasible, the generation of hazardous waste is to be reduced or eliminated as expeditiously as possible. Waste that is nevertheless generated should be treated, stored, or disposed of so as to minimize the present and future threat to human health and the environment.

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[22] The Hazardous and Solid Waste Amendments are Public Law 98-616, dated Nov. 8, 1984. This law officially amended the Solid Waste Disposal Act, which is commonly referred to by the sweeping amendments passed in 1976: The Resource Conservation and Recovery Act (RCRA). Hereafter, the Hazardous and Solid Waste Amendments will be referred to as the 1094 RCRA Amendments, or the amendments. Waste minimization was only one of many changes made to RCRA in 1984.

With this language and the implementation sections that follow, Congress defined a two-tiered national waste minimization policy. First and foremost, the generation of hazardous waste is to be *reduced* or eliminated. Second, the management of waste that is generated should follow practices that *minimize* risks. Concern about the continuing and long-term risks of hazardous substances formed the basis of this new policy in which three basic facts are recognized: hazardous waste that is not generated poses no risk to human health and the environment; good management practices can lower the risks of hazardous waste that is generated; and land disposal is the least preferred management practice.

These concerns were reiterated in a new paragraph of RCRA where specific methods for achieving the stated national policy are included. This objective states that one of the ways in which the protection of health and the environment is to be promoted is by:

> . . . minimizing the generation of hazardous waste and the land disposal of hazardous waste by encouraging process substitution, materials recovery, properly conducted recycling and reuse, and treatment . . . [23]

OTA's Waste Reduction

The RCRA national policy statement is the basis for this OTA study. The assessment is confined to the first part of that policy: the technical, industrial, and governmental aspects of actions to reduce the generation of hazardous waste. The second part of the national policy statement, hazardous waste *management*, was assessed in OTA's 1983 report, *Technologies and Managment Strategies for Hazardous Waste Control*.[24]

Even though the amendment consistently refers to "hazardous waste," OTA has included more than RCRA hazardous wastes in this study. Close examination of techniques and practices labeled waste reduction, often reveals that when RCRA wastes are reduced air and/or water pollution can increase. Most of the waste minimization provisions of the 1984 RCRA amendments originated in the U.S. Senate bill, The Solid Waste Disposal Act Amendments of 1983 (S. 757). The Senate Public Works and Environment Committee's report on the waste minimization provisions of this bill voiced concern about " . . . pollutants contained in effluents, emissions, wastes or other pollution streams . . . "[25]

Thus, in this report OTA has considered the reduction of the generation of all wastes and has defined hazardous wastes as all nonproduct hazardous outputs from an industrial operation into all environmental media, even though they may be within permitted or licensed limits. (See ch. 1 for OTA's definitions of waste reduction and hazardous waste.)

Waste Minimization Requirements

Three specific activities to implement national policy were mandated by Section 224 of the 1984 RCRA amendments. These requirements apply to generators of RCRA hazardous waste[26] who manage their wastes onsite or to those who ship wastes offsite. In addition, EPA, as the agency delegated to carry out RCRA policies, was told to study the "Minimization of Hazardous Waste" further and report back to Congress.

Specifically, Congress required:

- *Reporting Procedures*:[27] Generators subject to reporting requirements were to include " . . . efforts undertaken during the year to reduce the volume and toxicity of waste generated; and . . . the changes in volume and toxicity of waste actually achieved during the year in question in comparison with previous years, to the extent such information is available for years prior to [Nov. 8, 1984]."
- *Manifest System*:[28] A section on waste minimization was added to require a gener-

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[23] Solid Waste Disposal Act (SWDA), Section 1003(a)(6)

[24] OTA, op. cit., March 1983

[25] U.S. Congress, Senate Committee on Environment and Public Works, *Solid Waste Disposal Act Amendments of 1983*, Report No. 98-284, Oct. 28, 1983, p. 65.

[26] 40 CFR 260.10 defines generators as "any person, by site, whose act or process produces hazardous waste identified or listed in Part 261 of this chapter or whose act first causes a hazardous waste to become subject to regulation."

[27] SWDA, Section 3002(a)(6), Standards applicable to generators of hazardous waste.

[28] Ibid., paragraph (b)

ator's certification on the manifest for all regulated offsite shipments of hazardous waste, effective September 1, 1985. The certification was to state that, "the generator of the hazardous waste has a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable; and . . . the proposed method of treatment, storage, or disposal is that practicable method currently available to the generator which minimizes the present and future threat to human health and the environment."

- *Permits*:[29] A section on waste minimization was added saying that, effective September 1, 1985, as a condition of any permit issued for the treatment, storage, or disposal of hazardous waste on the premises where such waste was generated the permittee certify, no less often than annually, that, "the generator of the hazardous waste has a program in place to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable; and . . . the proposed method of treatment, storage, or disposal is that practicable method currently available to the generator which minimizes the present and future threat to human health and the environment."
- *EPA Study*:[30] Congress required EPA to submit a report to Congress on "the feasibility and desirability of establishing standards of performance or of taking other additional actions under this Act to require the generators of hazardous waste to reduce the volume or quantity and toxicity of the hazardous waste they generate, and of establishing with respect to hazardous wastes required management practices or other requirements to assure such wastes are managed in ways that minimize present and future risks to human health and the environment. Such report shall include any recommendations for legislative changes which the Administrator determines are feasible and desirable to implement the national policy established by section 1003." The report is due October 1, 1986.

Two Tiers of Waste Minimization

Each implementation section in the 1984 RCRA amendments is titled *Waste Minimization* and, like the national policy statement, is composed of two parts. The first part is concerned with the reduction of the generation of hazardous waste; the second with proper management of that which is generated. Some of the language in the implementation sections, however, is not as clear as that in the national policy. Phrases such as "reduce the volume or quantity and toxicity of such waste," and "reduce the volume and toxicity of waste generated" can be interpreted as instructions either to: 1) reduce the generation of hazardous waste, or 2) reduce waste that has been generated. The first phrasing clearly instructs generators to practice pollution *prevention*. The second, however, implies pollution *control*, a management activity that takes place after a pollutant is generated. In requiring EPA to study the "Minimization of Hazardous Waste," ambiguity appears again in the phrase "to reduce . . . the hazardous waste they generate." This imprecision can shift or blur the hierarchy of activities based on risk that the national policy seeks (i.e., the primacy of waste reduction).

If the national policy statement is used as a guide to interpretation of the implementation sections, the intent of Congress seems clear. **Waste minimization is an overall goal composed of two unequal parts.** Within the context of voluntary waste reduction, generators should move as expeditiously as possible to reduce the generation of hazardous waste. This practice requires the alteration of industrial processes and operating procedures—a front-end approach that is pollution prevention. Congress recognized that zero reduction is usually not possible and stated that, for those wastes that are produced, *good* management practices (traditional end-of-pipe control) should be established.

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[29] Ibid., Section 3005(h), Permits for treatment, storage, or disposal of hazardous waste.

[30] Ibid., Section 8002(r), Special studies; plans for research, development, and demonstrations.

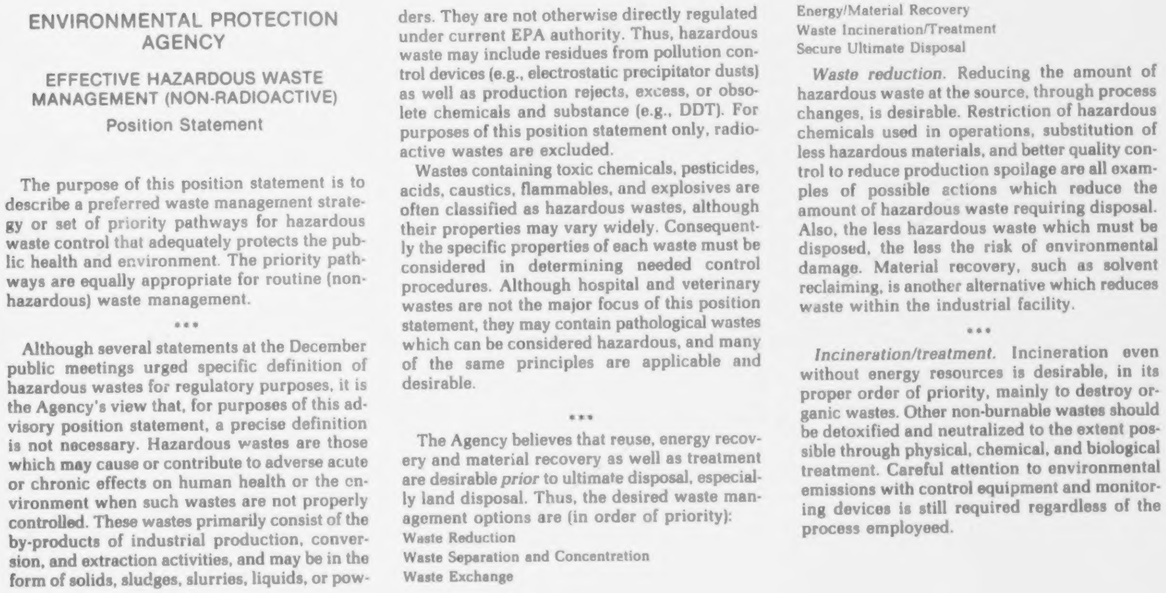
The Regulations

Ten years ago, EPA published a preferred waste management strategy in the *Federal Register* that established waste reduction as the priority option (see figure 5-2). Rules and regulations pertaining to waste minimization were finalized on July 15, 1985.[31] **The clear statement giving priority to waste reduction that was provided by the RCRA national policy statement (and EPA's earlier one) is not repeated in the regulations**. Instead, the language and positioning of the regulations appear to shift the emphasis of waste minimization from reducing the generation of hazardous waste to reducing land disposal as a hazardous waste management practice.

The language used consistently in the regulations is the ambiguous "to reduce the volume or quantity and toxicity of waste generated." In the explanatory preamble to the regulations, the terms *minimize* and *reduce* are used interchangeably, a practice not followed in the amendments. These imprecisions in translating statute to regulations have served to guide generators away from reducing the generation of wastes—or even from examining the possibility of reducing the generation of wastes—before turning to waste management alternatives.

RCRA waste minimization regulations include: 1) a waste minimization statement added to the Uniform Hazardous Waste Manifest;[32] 2) two waste minimization information items added to the biennial report required of generators;[33] and 3) a provision that each generator holding a treatment, storage, and disposal facility (TSDF) permit record a waste minimization certification in the written operating record kept at the facility.[34] EPA made it clear that the last provision applied only to *generators* of hazardous waste, as the language in the amendments stated. This exemption emphasizes the importance of waste reduction over other as-

Figure 5-2.—EPA's Statement on Preferred Options



ENVIRONMENTAL PROTECTION AGENCY

EFFECTIVE HAZARDOUS WASTE MANAGEMENT (NON-RADIOACTIVE)

Position Statement

The purpose of this position statement is to describe a preferred waste management strategy or set of priority pathways for hazardous waste control that adequately protects the public health and environment. The priority pathways are equally appropriate for routine (nonhazardous) waste management.

* * *

Although several statements at the December public meetings urged specific definition of hazardous wastes for regulatory purposes, it is the Agency's view that, for purposes of this advisory position statement, a precise definition is not necessary. Hazardous wastes are those which may cause or contribute to adverse acute or chronic effects on human health or the environment when such wastes are not properly controlled. These wastes primarily consist of the by-products of industrial production, conversion, and extraction activities, and may be in the form of solids, sludges, slurries, liquids, or powders. They are not otherwise directly regulated under current EPA authority. Thus, hazardous waste may include residues from pollution control devices (e.g., electrostatic precipitator dusts) as well as production rejects, excess, or obsolete chemicals and substance (e.g., DDT). For purposes of this position statement only, radioactive wastes are excluded.

Wastes containing toxic chemicals, pesticides, acids, caustics, flammables, and explosives are often classified as hazardous wastes, although their properties may vary widely. Consequently the specific properties of each waste must be considered in determining needed control procedures. Although hospital and veterinary wastes are not the major focus of this position statement, they may contain pathological wastes which can be considered hazardous, and many of the same principles are applicable and desirable.

* * *

The Agency believes that reuse, energy recovery and material recovery as well as treatment are desirable *prior* to ultimate disposal, especially land disposal. Thus, the desired waste management options are (in order of priority):

Waste Reduction
Waste Separation and Concentration
Waste Exchange
Energy/Material Recovery
Waste Incineration/Treatment
Secure Ultimate Disposal

Waste reduction. Reducing the amount of hazardous waste at the source, through process changes, is desirable. Restriction of hazardous chemicals used in operations, substitution of less hazardous materials, and better quality control to reduce production spoilage are all examples of possible actions which reduce the amount of hazardous waste requiring disposal. Also, the less hazardous waste which must be disposed, the less the risk of environmental damage. Material recovery, such as solvent reclaiming, is another alternative which reduces waste within the industrial facility.

* * *

Incineration/treatment. Incineration even without energy resources is desirable, in its proper order of priority, mainly to destroy organic wastes. Other non-burnable wastes should be detoxified and neutralized to the extent possible through physical, chemical, and biological treatment. Careful attention to environmental emissions with control equipment and monitoring devices is still required regardless of the process employeed.

SOURCE: Federal Register, vol. 41, No. 61, Aug. 18, 1976.

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[31] 50 Federal Register 28702.

[32] 40 CFR, Appendix to Part 262.

[33] 40 CFR Part 262.41.

[34] 40 CFR Part 264.73(b)(9).

pects of waste minimization. TSDF permit holders who are not generators would not be able to practice waste reduction since it must occur where wastes are produced. They can and should, however, be expected to practice good waste management.

The Manifest Certification

The waste minimization statement is included as a part of the Generator's Certification on the manifest and reads:

> . . . Unless I am a small quantity generator who has been exempted by statute or regulation from the duty to make a waste minimization certification under Section 3002(b) of RCRA, I also certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and I have selected the [practical][35] method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment.

The Biennial Report

Under RCRA, both generators who ship hazardous wastes offsite and those who generate and/or treat, store, or dispose of hazardous waste onsite must submit a biennial report by March 1 of each even numbered year. Only those generators who ship *offsite* (the same group subject to the manifest certification) are subject to the new waste minimization biennial reporting regulation. They are required by EPA to include in their reports:

> . . . a description of the efforts undertaken during the year to reduce the volume and toxicity of waste generated . . . [and] . . . a description of the changes in volume and toxicity of waste actually achieved during the year in comparison to previous years to the extent such information is available for years prior to 1984.

EPA placed these regulations under Part 262.41(a) of the RCRA regulations. Generators who treat, store, or dispose of hazardous waste *onsite* are subject to biennial reporting requirements under Part 262.41(b) and, thus, do not have to report biennially on waste minimization efforts.[36]

The Permitting Condition

This third provision of the waste minimization regulations requires permittees who treat, store, or dispose of hazardous waste onsite where such wastes are generated to certify:

> . . . no less often than annually, that the permittee has a program in place to reduce the volume and toxicity of hazardous waste *that he generates*[37] to the degree determined by the permittee to be economically practicable; and the proposed methods of treatment, storage or disposal is that practicable method currently available to the permittee which minimizes the present and future threat to human health and the environment.

This certification must be placed in the operating file that is maintained on the site of the TSD permitted facility.

Consequences of the Regulations

As a result of the way in which Congress wrote the legislation and EPA the regulations, generators of hazardous waste have been unevenly hit, no enforcement can reasonably take place, and little evaluation can be made as to whether the goals of waste minimization are being met. **The regulatory program will not make possible the determination of whether waste reduction is taking place.** Table 1-1 in chapter 1 summarizes how effectiveness has been eroded by the statute, regulations, and their implementation.

While many generators may operate in both modes, those who ship their hazardous wastes offsite are subject to two regulations; those who operate as a TSDF are subject to one. Small quantity generators (SQGs), on the other hand, are subject to the manifest certification but do not need to comply with the waste minimization portion of the biennial report.[38] Table 5-3 gives a breakdown of the types of generators under RCRA and the waste minimization regulations to which each is subject.

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[35] The word *practical* which appears in the amendments was omitted from this statement in the regulations.

[36] It can be argued that these onsite managed wastes are not as potentially hazardous to the general public as those transported offsite, due to the lesser number of people with which they come in contact. However, many hazardous waste disposal sites that are now being cleaned up under the Federal Superfund program or by private parties are located on the sites where the wastes were generated. The potential damage to the Nation's groundwater is largely unknown.

[37] Italics added for emphasis to indicate another change in phrasing.

It will be difficult to evaluate how effectively waste minimization is being implemented. Data collected because of the regulations will be sparse and inconclusive. Only the biennial reporting regulation requires an actual description of voluntary efforts and the submission of time series data to show whether wastes have been reduced or not. (Both the manifest and permit certification only require *a statement* that such a program is in place and that wastes that are generated are being managed properly.) The information provided by the biennial reports will be from a small subset of the Nation's RCRA hazardous waste generators, as the reporting ignores those wastes that are managed on the site of generation.[39] In addition, as discussed in chapter 4 of this report, true waste reduction can be disguised in waste generation trend data by changes in production, changes in the amount of nonhazardous constituents in waste streams, regulatory changes, and cross-media shifts. Despite this complication, the regulations do not provide any guidance to generators on appropriate waste minimization measures.

A potential change in the emphasis of national policy arises out of the way that EPA wrote the regulation regarding TSDFs. *Language appears in this regulation that never appeared in the amendments and does not appear in the other regulations.* A TSDF permittee is told that it is a condition of his permit that he reduce the wastes *that he generates*. This phrasing implies an end-of-pipe approach to waste minimization and is inconsistent with the fact that TSDFs that only manage wastes are not covered by waste minimization regulations. Either EPA has placed a TSDF permittee in a different category with regard to waste minimization or the ambiguous phrases used elsewhere (under manifesting and reporting) can be interpreted in this latter fashion.[40]

From EPA's perspective, enforcement is not an important aspect of these regulations, as is consistent with Congress' objective of encouraging voluntary efforts. In the *Federal Register* notice, EPA cited legislative history[41] as making it clear that the amendments do not authorize EPA to interfere with or to intrude into the production process. Reinforcing the voluntary nature of current waste reduction activities, the "economically practicable" test for the reduction of the generation of hazardous waste and the "practical method" test of hazardous waste management are to be defined individually by each generator.

EPA, however, stated a concern with compliance "with the certification signatory require-

Table 5-3.—Waste Minimization Regulations

	Regulations		
Generators	Manifest certification	Biennial report	Permit certification
Offsite shipment	X	X	O
Onsite TSDF	O	O	X
Small quantity	X	O	X[a]

X = required; O = not required.

[a] Only SQGs holding wastes more than 180 days need to obtain a TDF permit.

SOURCE: Office of Technology Assessment.

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[38] The 1984 amendments mandated EPA to promulgate standards by Mar. 31, 1986, for Small Quantity Generators who generate between 100 and 1,000 kilograms per month. The statute exempted SQGs from TSDF permitting requirements if they store onsite up to 180 days, rather than 90 days. EPA wrote the SQG regulations such that SQGs are not subject to the waste minimizations biennial reporting requirements. They are, however, subject to the full manifesting provisions of RCRA. Thus, the waste minimization certificate on the manifest form must be signed. [51 Federal Register 10146, Mar. 24, 1986.]

[39] The State of California has recognized this coverage deficiency of the biennial reports. A law was enacted in September 1985 (Assembly Bill No. 685) that imposes the reporting requirements as a TSDF permitting condition for generators who manage wastes on the site of generation. The language adopted was that of the 1984 RCRA Amendments, however, so that while the State will be receiving more information from a larger universe of generators, it will be the same inconclusive information.

[40] When the biennial reporting regulations were translated into the instructions on the form, the phrase reads: "reduce the volume and toxicity of the hazardous waste *which your business generates*." [U.S. Environmental Protection Agency, Hazardous Waste Generator Report for 1985, EPA Form 8700 - 13A (5-80) Revised (11-85).]

[41] Using the Senate Report No. 98-284 on S.757. See previous citation.

ment" which it identifies as the manifest certification.[42] Manifests are not collected by EPA. They are sequentially routed along with each batch of hazardous waste and end up wherever the material comes to rest. Copies of manifests (with the certification) are not routinely inspected by EPA. Similarly, the waste minimization certifications made by TSDFs are placed onsite. Verification of compliance could only be made by collecting such documents from the 5,000 national TSD permitted facilities. Given the language used in the regulations, however, verification of a signed certification, would not indicate whether a generator has: 1) a program to reduce the generation of hazardous waste, 2) a program to reduce waste that is generated, or 3) a program that combines both. OTA could not find *any* evidence of any enforcement activity underway.

The EPA Report to Congress

In requiring EPA to study waste minimization, Congress broke the task into the two components of waste minimization. Both parts deal with establishing *requirements* (i.e., no longer a voluntary program) that generators comply with national policy. In the first part EPA is to advise on possible methods to *require* the reduction of the generation of hazardous waste. In the second, EPA is to advise on *required* good management practices for those wastes that are generated. Because EPA's effort was ongoing during OTA's study, OTA has not been privy to the content of EPA's forthcoming report to Congress. Sources of information that are available include statements made by EPA officials preparing the report and drafts of contractor background reports.

EPA recognizes that the 1984 RCRA Amendments failed " . . . to give [a] clear and concise definition of the term waste minimization . . . "[43] However, instead of using the national policy statement in the amendments as the basis for its working definition of "waste minimization," EPA has consulted legislative history (Senate Report No. 98-284) and, it says, sought advice from outside organizations such as the Great Lakes Regional Waste Exchange and the National Association of Solvent Recyclers.[44] Its definition of waste minimization becomes:[45]

> Any source reduction or recycling activity undertaken by a generator that results in (1) the reduction of total volume of hazardous waste or (2) the reduction of quantity and toxicity of hazardous waste, that is either generated or subsequently treated, stored, or disposed. Such activities must be consistent with the goals of minimizing present and future threats to human health and the environment.

Source reduction is subsequently defined as:

> Any activity that reduces or eliminates the generation of a hazardous waste in a process.

and a material as being recycled if:

> . . . it is used, reused, or reclaimed.

EPA's *source reduction* is analogous to OTA's *waste reduction*. But, the emphasis of national policy on waste reduction (i.e., its primacy) is lost in the EPA definition of waste minimization. Source reduction activities are front-end practices which by their nature minimize hazardous substances and therefore lessen public health and environmental risk. But in EPA's definition these practices carry no precedence over recycling. The phrase "that is either generated or subsequently treated, stored, or disposed" implies that waste minimization can take place either before the wastes are generated or after.

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[42] 50 Federal Register 28734, July 15, 1985.

[43] James R. Berlow, Treatment Technology Section, U.S. Environmental Protection Agency, speech before the "Hazardous and Solid Waste Minimization" conference of the Government Institutes, Inc., May 8-9, 1986.

[44] Ibid.

[45] Ibid.

EPA'S IMPLEMENTATION OF WASTE MINIMIZATION

The Office of Solid Waste (OSW), one of three major units under EPA's Assistant Administrator for Solid Waste and Emergency Response, is charged with implementing RCRA. OSW is awaiting the findings of its report to Congress to proceed with any waste minimization activities beyond the promulgation of the regulations mandated by the 1984 RCRA Amendments.[46] Meanwhile, little oversight is being conducted of the implementation of those regulations, and no waste minimization organizational entity has been set up within EPA. Waste minimization is not a budget item; the issue is given only passing reference in EPA's fiscal 1987 budget justification document.

With the inclusion of waste minimization in the 1984 RCRA Amendments, Congress gave some attention to the issue of reducing the generation of waste. In regulating and implementing waste minimization, EPA is caught between the statute's call for regulations and congressional intent that they not be intrusive. Should enforcement occur, EPA has no criteria of its own with which to judge compliance. Congress left the choice of exactly how to meet the regulations up to the regulated community by providing that substantive determination of "economically practicable" and "practicable method currently available" be made by the generator. Further, **the statute did not explicitly define waste minimization and EPA did not define it in the regulations. As a result, not only the choice of actions but also the determination of what actions constitute waste minimization has been left up to the regulated community.**[47]

A Low-Priority Issue

In keeping with Congress' initial low-key approach to waste minimization, OSW has not assumed a leadership role and considers waste minimization a low-priority item on its agenda. If considered at all, waste minimization is something for the future. This lack of priority and of any distinctiveness given to waste minimization by EPA is reflected in many OSW statements, actions, and publications. A draft document, "Hazardous Waste Implementation Strategy," produced by OSW in March 1986, analyzes ways to incorporate all the 1984 RCRA Amendments into the existing program. It also provides some insight into OSW's thoughts about potential waste minimization options. Within the short-term strategy section, waste minimization receives only scant mention, as a way to shift more responsibility to waste generators. Under the long-term strategy (beyond 4 years), waste minimization becomes "the long-run solution to many of [our] current problems and should be a major component of our long-run strategy."[48] The document then discusses how increasing regulatory burdens will make "this concept . . . feasible." Options are presented that range from "voluntary implementation and technology transfer to promulgating uniform waste generation limits by industry category." The latter are presented in terms of waste streams, whether they are untreatable and whether they are low or high risk. Untreatable wastes, for instance, could be subject to minimization levels while minimization of low-risk wastes could be affected by technology transfer and outreach programs. A "marketable permits approach" could be considered for high-risk, untreatable wastes.

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[46] Marcia Williams, Director, Office of Solid Waste, U.S. Environmental Protection Agency, statement to OTA, Mar. 13, 1986.

[47] A de facto definition is evolving, however. The principal contractor for EPA's report to Congress on waste minimization has been making speeches at conferences and seminars over the last year using a definition of waste minimization that includes waste reduction, recycling *and treatment*—any activity short of land disposal. Because of the contractor's known connection with EPA, industry has been adopting this definition, despite the fact that EPA's own later working definition for the report does not include treatment.

[48] U.S. Environmental Protection Agency, Office of Solid Waste, "Hazardous Waste Implementation Strategy," undated draft (copy made available to OTA from OSW in April 1986), p. 26. In the April 1986 issue of *EPA Journal*, the director of OSW was quoted as saying that this document, which concentrates on pollution control, was to serve as a catalyst for discussion about what is really important and key in the implementation of RCRA.

A brochure, *Highlights of the Hazardous and Solid Waste Amendments of 1984: The New RCRA Requirements*[49] is sent in response to all inquiries received about RCRA. A copy of the brochure is presented as figure 5-3. Where is there any mention of waste minimization? Is it one of the "major changes?" Is it among the list of the new law's "significant provisions?"

In the Hazardous Waste section of EPA's *Operating Guidance FY 1987*, waste minimization is not one of eight program priorities. It appears, instead, under a subsection on "new initiatives" within Goal III: "Anticipate and prevent future environmental problems and maintain high levels of environmental quality." Other than announcing the anticipated report to Congress, the single paragraph devoted to the subject states that waste minimization "holds promise for helping to abate capacity shortfalls and for assuring the public that effective efforts are being made to manage waste responsibly." In other words, waste minimization *might* help to control pollution; *no* value is placed on prevention. The only action indicated for 1987 is the vague statement: "secure implementation of appropriate waste reduction/minimization methods."[50]

The Office of Solid Waste was reorganized in May 1986, but the opportunity was not used to raise the visibility of or bestow any importance on waste minimization or waste reduction. In fact, the opposite appears to have occurred. Previous to OSW's reorganization, the group preparing the waste minimization report to Congress was located in the Treatment, Recycling, and Reduction Program, five levels below the Assistant Administrator. Under the reorganization, this program was renamed the Treatment Technology Section. It remains five levels down and under the Waste Treatment Branch of the Waste Management Division (ex-Waste Management and Economics Division) of OSW. The Waste Treatment Branch is given "primary responsibility for the assessment of technologies and promulgation of regulations, guidelines, and guidances for the storage, treatment, incineration, and recovery of hazardous wastes." In the reorganization announcement, the only time the words "waste minimization" appear is as the last of the Waste Management Division's 32 assigned functions: "Developing the Report to Congress on Waste Minimization."[51]

Waste Minimization Oversight

It is a reflection of the lack of any focus on waste minimization that responsibility for the current requirements of the 1984 RCRA Amendments is shared by many portions of OSW. As mentioned, the report to Congress is being prepared by the Treatment Technology Section. The manifest certification, biennial reporting, and permitting provisions are assigned to offices normally responsible for such activities. The State Programs Branch has overall responsibility for seeing that the 1984 amendments are implemented at the State level; EPA Regional Offices are responsible for implementation in those States without authorized RCRA programs.[52]

The 1984 amendments provided that all requirements or prohibitions of the act pertaining to the generation, transportation, treatment, storage, or disposal of hazardous waste were to take effect in all authorized and nonauthorized States at the same time. EPA was directed to carry out such requirements and prohibitions directly in a State until the State became authorized to do so. EPA decided that all the RCRA rules promulgated on July 15, 1985, including those regarding waste minimization,

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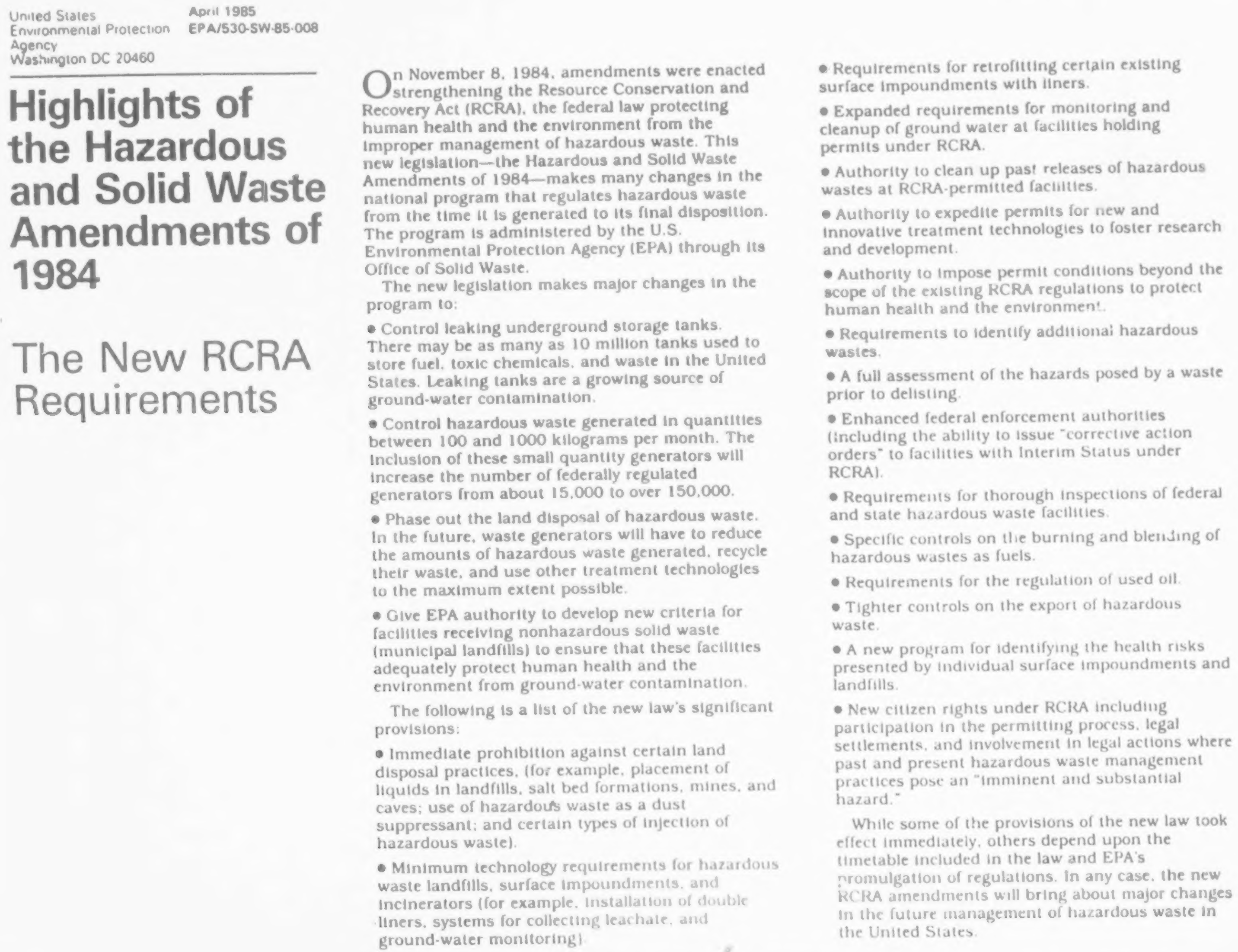
[49] U.S. Environmental Protection Agency, EPA/530-SW-85-008, April 1985.

[50] U.S. Environmental Protection Agency, *Operating Guidance FY 1987* (Washington, DC: Office of the Administrator, March 1986), p. 37.

[51] Gary M. Katz, Director, Management and Organization Division, U.S. Environmental Protection Agency, memorandum on "Reorganization of the Office of Solid Waste," to Howard M. Messner, Assistant Administrator, May 7, 1986.

[52] The number of States with RCRA authorization changes from time to time; as newly authorized States are added, existing authorized States can lose that status by not adhering to the rules. In March 1986, 33 States had received final authorization to operate RCRA programs. No States, at that time, had authorization to implement the 1984 amendments. Federal and State RCRA people often use the terms *pre-HSWA authorization* and *post-HSWA authorization* to distinguish between the latter two possible states of State RCRA authority.



United States
Environmental Protection
Agency
Washington DC 20460

April 1985
EPA/530-SW-85-008

Highlights of the Hazardous and Solid Waste Amendments of 1984

The New RCRA Requirements

On November 8, 1984, amendments were enacted strengthening the Resource Conservation and Recovery Act (RCRA), the federal law protecting human health and the environment from the improper management of hazardous waste. This new legislation—the Hazardous and Solid Waste Amendments of 1984—makes many changes in the national program that regulates hazardous waste from the time it is generated to its final disposition. The program is administered by the U.S. Environmental Protection Agency (EPA) through its Office of Solid Waste.

The new legislation makes major changes in the program to:

- Control leaking underground storage tanks. There may be as many as 10 million tanks used to store fuel, toxic chemicals, and waste in the United States. Leaking tanks are a growing source of ground-water contamination.
- Control hazardous waste generated in quantities between 100 and 1000 kilograms per month. The inclusion of these small quantity generators will increase the number of federally regulated generators from about 15,000 to over 150,000.
- Phase out the land disposal of hazardous waste. In the future, waste generators will have to reduce the amounts of hazardous waste generated, recycle their waste, and use other treatment technologies to the maximum extent possible.
- Give EPA authority to develop new criteria for facilities receiving nonhazardous solid waste (municipal landfills) to ensure that these facilities adequately protect human health and the environment from ground-water contamination.

The following is a list of the new law's significant provisions:

- Immediate prohibition against certain land disposal practices, (for example, placement of liquids in landfills, salt bed formations, mines, and caves; use of hazardous waste as a dust suppressant; and certain types of injection of hazardous waste).
- Minimum technology requirements for hazardous waste landfills, surface impoundments, and incinerators (for example, installation of double liners, systems for collecting leachate, and ground-water monitoring).
- Requirements for retrofitting certain existing surface impoundments with liners.
- Expanded requirements for monitoring and cleanup of ground water at facilities holding permits under RCRA.
- Authority to clean up past releases of hazardous wastes at RCRA-permitted facilities.
- Authority to expedite permits for new and innovative treatment technologies to foster research and development.
- Authority to impose permit conditions beyond the scope of the existing RCRA regulations to protect human health and the environment.
- Requirements to identify additional hazardous wastes.
- A full assessment of the hazards posed by a waste prior to delisting.
- Enhanced federal enforcement authorities (including the ability to issue "corrective action orders" to facilities with Interim Status under RCRA).
- Requirements for thorough inspections of federal and state hazardous waste facilities.
- Specific controls on the burning and blending of hazardous wastes as fuels.
- Requirements for the regulation of used oil.
- Tighter controls on the export of hazardous waste.
- A new program for identifying the health risks presented by individual surface impoundments and landfills.
- New citizen rights under RCRA including participation in the permitting process, legal settlements, and involvement in legal actions where past and present hazardous waste management practices pose an "imminent and substantial hazard."

While some of the provisions of the new law took effect immediately, others depend upon the timetable included in the law and EPA's promulgation of regulations. In any case, the new RCRA amendments will bring about major changes in the future management of hazardous waste in the United States.

Figure 5-3.—EPA Brochure on "The New RCRA Requirements"

met that test and therefore were to "take effect in authorized States and are Federally enforceable."[53] Thus, until States are authorized under the 1984 amendments, the burden is placed on EPA to implement those amendments.

As of March 1986 (8 months after the regulations were promulgated) little oversight was being provided by EPA. OSW was not aware of which States had adopted the new Uniform Manifest, whether the biennial reporting forms in use requested the required waste minimization program information, or whether the waste minimization conditions were being included as a permit condition for TSDFs. OTA conducted a telephone survey during the last 2 weeks in March 1986 to ascertain how much implementation was underway since the information was not available from OSW. In some cases, EPA Regional Offices could supply the information; in others it was necessary to contact State RCRA offices.

One particular comment made repeatedly to OTA by people in EPA Regional Offices and in State RCRA offices was that no guidance was provided by OSW to EPA Regional Offices, States, or generators as to what constitutes "waste minimization" or a waste minimization program. The rationale for this lack of guidance apparently derives from the nonintrusive intent of the statute, which allows actions to be determined by generators. **The consequence of this lack of guidance—especially of any attempt to define waste minimization—is confusion among generators and regulatory staff and a lack of any consistency in reporting.**

Manifest Certification

The waste minimization certification statement was added to the Uniform Manifest; and the new manifest became effective on September 1, 1985. The results of the telephone survey by OTA showed that, in general, States have adopted the use of the new manifest for offsite shipments.

The position of the waste minimization statement on the manifest form caused some concern among generators. It was added as a second paragraph to an already existing statement certifying that the information on the form was correct. In many firms a shipping supervisor had been responsible for signing that certification. It was not appropriate for that person to certify, as well, that the firm had a waste minimization program in place.

There is no Federal enforcement of manifests; the regulated community is relied on to monitor compliance and report possible violations of the tracking system. Some States do collect manifests, primarily to obtain waste generation data.[54]

Biennial Reporting

Under RCRA regulations, all generators and TSDFs must report the previous year's activities biennially (in even numbered years).[55] This reporting system was first used in 1984 (covering 1983), and the second reporting was done in 1986. In States with RCRA authority, generators and TSDFs report to their State, which in turn must send a summary of the collected information to EPA. In States without RCRA authority, generators and TSDFs report to the EPA region covering their State. The EPA region is then responsible for the summary report to EPA. Generators and TSDFs must report by March 1; States and EPA Regional Offices have until September 30 to submit a summary report to EPA.

The last set of information collected by the biennial report in 1984 was never aggregated to provide data on a national level about the state of waste generation in 1983. A major problem encountered by EPA was the lack of consistency of waste definitions among States. Few, if any, of the problems that prevented aggregation of the 1983 data were corrected prior to the collection of the 1985 data.

Biennial reporting is the only one of the three waste minimization activities in which the statute language specifically requires generators to indicate any changes in volume and toxicity of waste over the previous year. But neither the statute nor the regulations provide a standard and appropriate measurement method. As a result, the data collected will be inconclusive. It will also be sparse, because this reporting is only required of those who ship wastes offsite, a subset of the Nation's generators.

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[53] 50 Federal Register 28729, July 15, 1985.

[54] For instance, New York, New Jersey, California, Michigan, Pennsylvania, and Illinois collect a copy of the manifest and computerize the data.

[55] Some States require annual reporting.

EPA did not forewarn generators about the new waste minimization reporting requirements. The EPA form for 1985 reporting included three-quarters of a page titled "Section XVI. Waste Minimization (narrative description)." The complete instructions for this section are:

> Describe in the space provided your efforts, undertaken during calendar year 1985, to reduce the volume and toxicity of the hazardous waste *which your business generates*. Also describe changes in waste volume and toxicity actually achieved during 1985 in comparison to previous years, to the extent possible.[56]

Some States have their own forms; some have used the EPA form. Some, such as Minnesota, used the previous 1983 form as a guide and the result was that they failed to collect the waste minimization information. One State, New Jersey, went beyond the Federal requirement and included with the reporting form a survey for generators to complete on waste minimization activities. This was not done because New Jersey saw a need for a more systematic collection of information. Instead, State officials were afraid that without providing some further explanation of "waste minimization" they would be overloaded with telephone calls from generators wondering what that narrative statement should contain (see ch. 6).

EPA did not provide any supplemental information to generators about the new reporting requirements. One EPA official was advising generators who asked for guidance about their narrative statement to consult the statute (rather than the regulations). They were also informed that simply stating: "I have no waste minimization program" would be acceptable since the statute language did not *require* generators to have such a program. Procedural guidance was given to EPA regions for those required to conduct the biennial reporting for unauthorized States but no guidance was provided to authorized States. EPA considers the burden of reporting to be on generators to follow the statute and regulations, whether or not the State form includes a request for a waste minimization statement.

Despite the lack of EPA oversight, a majority of States appear to have included a waste minimization statement requirement. This information, however, will be kept at the State level as States do not have to include waste minimization information on the summary that they must supply to EPA by the end of September. Because of the lack of guidance given to generators as to what constitutes waste minimization, there will be no consistency in the information that is reported to States or EPA. *Given the EPA language in the instructions that accompany its form, it should be expected that most generators will report on waste management rather than on waste prevention activities.*

Permitting

All TSDFs must obtain an operating permit from EPA (or their State if it has RCRA authority). The permit is issued in two steps: An interim (Part A) followed by a final (Part B) permit. So far, most TSDFs are operating with interim permits and can continue to operate that way until EPA or the State notifies them to apply for a Part B. Until States are authorized to implement the 1984 RCRA Amendments, a joint permitting system exists for new TSDF permits. A State can issue a permit covering the pre-1984 amendments and the EPA region attaches the additional 1984 amendment requirements.

In the case of permitting, EPA did offer guidance to Regional Offices. In a memo on September 1985,[57] it advised them on how to proceed with the waste minimization permit condition. In addition to providing the appropriate language,[58] the memo dealt with the joint permitting system. It suggested that if the waste minimization condition was the only 1984 RCRA Amendment condition of a permit, then a special arrangement could be worked out with the States (prior to authorization) whereby they could incorporate the waste minimization condition themselves when writing an onsite TSDF permit.

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[56] U.S. Environmental Protection Agency, Hazardous Waste Generator Report for 1985 [Form 8700 -13A (5-80) Revised (11-85)]. The section of the regulations covering the reporting requirements is also included as part of the form packet. Italics added for emphasis.

[57] Bruce R. Weddle, Director, Permits and State Programs Division, Office of Solid Waste and Emergency Response, U.S. Environmental Protection Agency, memo to Hazardous Waste Division Directors, Regions I-X, Sept. 11, 1985.

OTA found that the aspect of the waste minimization regulations that deals with permitting conditions was well understood at the region level. Either regions were assuming responsibility (under the joint permitting procedure) or held responsibility for unauthorized States or they had arranged to delegate the responsibility to the States. What was not clear at the regional and State levels was how to explain to generators just what constituted a waste minimization program. In other words, how to write the permit and what to write in the permit had been made clear. But, what generators with permits are expected to write up in their annual waste minimization statement was left unclear.

WASTE MINIMIZATION: A VOLUNTARY ENDEAVOR

From a nonintrusive regulatory statute, a contradictory *voluntary waste minimization program with mandatory reporting requirements* has been created. It is an attention getting approach that can cause those firms subject to the regulations—or, certain people in them—to give more thought to waste minimization. But, in the absence of an official definition for waste minimization, responses should predictably be more of the easy, familiar waste management actions that have been taken in the past. Growing awareness and the threat of a more stringent regulatory program may motivate some firms to do as much as seems feasible. But other firms uncertain about future legislation and/or regulations may do little, holding off on major changes to make sure that they will conform to future legislative and regulatory language. This latter response may be especially true in a regulatory environment with little enforcement.

As discussed above, however, certain legislative and regulatory aspects of the current, voluntary waste minimization program assure that neither a qualitative or quantitative evaluation of its impact can be objectively accomplished. All mandatory reporting is in a narrative form, and there is no recognized definition of waste minimization to at least standardize the reports.

Today there is no way to know with any certainty whether *waste reduction* has occurred or is the principal focus of action or even whether industrial practices are changing and *waste minimization* is underway. Three sources of information are available and can offer some indication of what is happening: 1) anecdotal evidence from firms in public statements about their waste minimization plans, 2) hundreds of case histories presented in the literature and at conferences, and 3) generator surveys conducted to ascertain attitudes and forecast waste reduction's potential. None of these sources can reliably provide the information being sought. Anecdotal evidence contributes to the body of knowledge but does not provide definitive information. Case histories only report positive experiences. Waste reduction forecasts are flawed because they fail to consider that *waste reduction technology* encompasses the entire arena of industrial production (see ch. 3).

Corporate Plans

While a number of firms have well-publicized waste minimization plans, firms without any plans are silent. Some positive response to the current voluntary program does not necessarily indicate a readiness throughout U.S. industry to embrace waste minimization. Moreover, for some of the same reasons that compliance does not necessarily follow regulations, plant activities can remain unrelated to corporate plans and statements. Many firms have supplied OTA with copies of their corporate waste minimization plans. The examples presented below, which show commitment by three firms, point out that the definition of waste minimization varies but tends to include waste reduction and waste management and that waste reduction is not given any primacy. In general, firms are reluctant to provide the level of detail that would give convincing proof of waste reduction because of proprietary concerns.

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[58] It is quite brief. An addition of the phrase "and (9 [on-site only])" to the Operating Record portion of the permit refers the permittee back to the 40 CFR 264.73 section where the operating record regulations are written. Paragraph (9) of that section contains the annual certification of waste minimization requirement.

A major U.S. firm has formed a Corporate Hazardous Waste Minimization Committee. It has instructed its plant managers on how to comply with the waste minimization regulations. Information has been requested from plant managers to form the basis of company reporting requirements. Included are: 1) quantities and nature of wastes generated per year, 2) procedures and technologies used in waste disposition, 3) steps taken to reduce the volume and/or toxicity of wastes generated, and 4) changes in volume and/or toxicity achieved. However, nowhere in the corporate documents is the distinction made between the reduction of the generation of wastes (waste reduction) and reduction of wastes that have already been generated (waste management). Also, the company has asked its plants to report volume *and/or* toxicity reduction, whereas the regulations ask for volume *and* toxicity reduction. While manufacturing process change is identified as a way to promote the reduction of wastes, the two research projects funded in 1986 (solidification and incineration) are intended to solve waste management problems not enhance the feasibility of waste reduction.

Another firm, a medium-sized chemical company, defined waste minimization in an internal notification about the new RCRA regulations. The definition includes generation minimization, recycle/reuse, treatment, and disposal. While the document does not explain the term *generation minimization*, its placement in the list of actions implies reduction of the generation of waste and the document does suggest that selecting production processes that minimize byproduct streams is the most cost-effective and efficient method of dealing with wastes.

Minimization is defined in a major chemical company's corporate plan as any waste reduction or waste management practice short of land disposal. Corporate policy does place waste reduction as the prime consideration, and the company has given detailed information in public forums about its waste reduction projects. Public relations brochures on the environmental policies of two of the company's plants contain graphs showing significant reductions in air releases and water *emissions* of specific hazardous wastes over 10 years despite increased product production at the plants. Left unsaid, however, is how the reductions were accomplished. Waste reduction receives a one-line mention in each brochure while the balance of the 24 pages deals with waste management. This emphasis on waste management leaves the impression that waste reduction was not the prime factor in the reduced levels and that pollution control or waste management may have occurred.

Case Histories

OTA reviewed the literature on waste reduction case histories (see ch. 3). Case studies pertain to both waste management (consistent with waste minimization) and waste reduction. In general, OTA found that often the data most critical for analysis were omitted. Hazardous substances were poorly identified, information about the concentrations of chemicals in waste streams was missing, and it was often difficult to ascertain whether the reported waste reduction involved volume or toxicity or both. In addition, because case histories have focused almost exclusively on RCRA wastes, air and water examples were difficult to obtain and often suspected shifts from RCRA to air or water could not be documented.

Surveys

Another way to determine the status of waste reduction is through a survey of generators.

One section of OTA's industry survey (see app. A) was to have been completed only by those firms that have engaged in waste reduction activities. Of the 99 firms that completed the survey, only four skipped that section. This high rate of response seems to imply that most firms have waste reduction activities underway. It could, however, also be a consequence of the fact that the survey respondents were biased toward waste reduction, and this bias should lead to a higher than normal activity level.

Other surveys have been conducted in the last year or so by a consulting firm while analyzing the need for hazardous waste facilities in several States. These surveys asked generators who ship wastes offsite to project their plant's potential for waste reduction. Thus, these firms were to respond about the current feasibility for waste reduction, given the extent of their knowledge, weight of current incentives to reduce wastes, and current disincentives to generate hazardous waste. In an indirect way these results can be seen as indicating the extent to which surveyed generators have considered waste reduction. These estimates of potential should be somewhat higher than activities actually underway. A compilation of the results for five States over a variety of industry categories and waste streams shows that the potential for waste reduction ranges from 4 to 47 percent. (For more information on these surveys, see ch. 3.)

Under the current waste minimization program, little definitive information is voluntarily made available that makes it possible to assess the current state of waste reduction and little is being collected for future analysis because of the waste minimization regulations in effect today. It is possible to say that some work is underway but not to say how much, how widespread it is across the Nation, or how environmentally significant it is.

THE EXISTING MEDIA PROGRAMS: WASTE REDUCTION OPPORTUNITIES AND PROBLEMS

The environmental programs with major nationwide influence on U.S. industry are those based on: the Resource Conservation and Recovery Act, the Clean Water Act, and the Clean Air Act. The impact of TSCA over the last 10 years has been primarily the cost to chemical manufacturers of reporting. The Superfund (CERCLA) program affects the economics of industrial activity directly through its taxing mechanisms and, indirectly, through liability provisions.

The following reviews of these major statutes, regulations, and programs offer some insight into the opportunities and problems associated with operating a waste reduction program within the context of the existing environmental protection system.[59] Table 5-4 contains general information about the programs and includes information on the Federal Insecticide, Fungicide, and Rodenticide (FIFRA) and Safe Drinking Water (SDW) programs, as well. As the table also shows, about $1 billion has been requested for Federal spending on these program for fiscal year 1987. Most of these funds cover pollution control; very little is spent on waste reduction. (See table 5-2 for a comparison on government spending for pollution control vs. waste reduction.)

Throughout the following analysis only the Federal level is considered. Some State environmental programs may effectively compensate for some of the Federal deficiencies. It is, however, beyond the scope of this report to analyze 50 State air, water, and hazardous waste regulatory programs. State waste reduction programs are the subject of chapter 6 in this report.

Resource Conservation and Recovery Act[60]

Since its beginnings, the RCRA program has been a waste management program. Through

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[59] In ch. 4 of this report, the relevance to waste reduction of the information and data collection systems of the current environmental programs is separately evaluated.

[60] The waste minimization actions mandated by the 1984 RCRA Amendments are discussed in preceeding sections of this chapter. This section covers other aspects of the RCRA program that pertain to waste reduction.

Table 5-4.—Comparison of Environmental Control Media Programs

Program	EPA office	Fiscal year 1987 request (millions $)[a]	Pollutants covered	Parties subject to regulation	Type of regulation
RCRA	Office of Solid Waste (under Assistant Administrator for Solid Waste and Emergency Response)	$256.2	Hazardous waste, either listed or by meeting characteristic test	Generators Transporters Treatment, storage, and disposal facilities (TSDFs)	Management standards; EPA sets by regulation
Clean Air	Assistant Administrator for Air and Radiation	$239.2	Air (criteria) pollutants Hazardous	Industrial sources Mobile sources	EPA sets emission limits/standards State or local authorities permit
Clean Water	Assistant Administrator for Water	$217.8	Conventional Toxic priority Nonconventional	Direct dischargers into U.S. waters including publicly owned treatment works (POTWs) Indirect dischargers (into POTWs)	By industrial category: emission guidelines set by EPA; allowed discharges set by permit Pretreatment standards set by EPA
TSCA	Office of Toxic Substances (under Assistant Administrator for Pesticides and Toxic Substances)	$ 89.3	Potentially any chemical; must be judged "unreasonable risk" Statute excludes some specific substances; prohibits manufacture of PCBs	Manufacturers and importers of chemicals	Can prohibit manufacture, require labeling, limit production, require recordkeeping, control disposal methods, require notification to customers
FIFRA	Office of Pesticide Programs (under Assistant Administrator for Pesticides and Toxic Substances)	$ 69.4	Pesticides	Manufacturers Users	EPA sets regulations on use, registers manufacturers, monitors residues States certify firms that apply pesticides
SDW	Office of Drinking Water (under Assistant Administrator for Water)	$ 84.1	Contaminants found in drinking water	Suppliers of drinking water Users of underground injection wells	EPA sets national allowable maximum concentration levels (MCLs) and regulations for users of injection wells States implement and enforce

[a] Budget data are from EPA's Budget Justification Document for fiscal year 1987.

SOURCE: Office of Technology Assessment.

the act or regulations, RCRA defines hazardous wastes; prescribes a manifesting system for all wastes shipped off the site of generation; and sets operating standards for generators of hazardous waste, for facilities that treat, store, or dispose of hazardous wastes, and for transporters of hazardous waste. Permits are required to operate treatment, storage, and/or disposal facilities.

While this management system sounds comprehensive, exclusions and operating inefficiency erode its effectiveness. Congress, in the 1984 RCRA Amendments, tried to fix the deficiencies by setting up a series of land disposal bans based on chemical classes, bringing small quantity generators into the system, requiring the control of underground storage tanks, and requesting studies on such recognized problems as discharges of hazardous wastes to publicly operated treatment works (POTWs) and on mine wastes.

The failure of land disposal to control pollution has become well known, especially under the companion Superfund program. In moving toward land disposal bans, the RCRA program is, however, also moving away from the current method of defining hazardous wastes. This change has implications for waste reduction. Traditionally, once a substance is defined as a hazardous waste, *any* amount or concentration of that waste is hazardous. There are no limits placed on the amount that can be generated, but once generated it must be managed in a prescribed manner. Waste reduction occurs when less of a hazardous waste is generated. Under initial plans for land disposal bans, EPA has developed a system of permissible water-borne releases, similar to the basic system used in the air and water programs. On a more comprehensive basis, but at a more preliminary stage within the RCRA program, is a plan to redefine the universe of hazardous wastes using a health-based model for setting permissible concentrations.[61] Should such a change eventually be adopted, a hazardous waste could be eliminated—in a regulatory sense—simply by lowering its concentration. If, under a health-based model, hazardous wastes are ranked by degree of hazard, then waste reduction could occur when a less hazardous material is substituted.

The land disposal bans process is also pushing the RCRA program toward "the use of treatment technologies on a large and comprehensive scale," despite the fact that " . . . waste minimization, recycling and reuse [are] the preferred solutions under RCRA."[62] (Preferred solutions, with waste reduction at the top of the list, were first officially articulated by EPA in 1976; see figure 5-2.) While millions of dollars are being spent by the RCRA program on land disposal bans and treatment technology, the expanded use of the stated preferred solutions is left to " . . . the normal operation of the marketplace."[63]

The POTW study[64] was conducted to determine if the Domestic Sewage Exclusion in RCRA should be repealed. This exemption states that domestic sewage and any "mixture of domestic sewage and other wastes that passes through a sewer system to a publicly-owned treatment works for treatment" is not a hazardous waste.[65] The rationale for this exemption under RCRA is that industrial wastes discharged to sewers are regulated by CWA's pretreatment standards. Among its findings, the study concluded that 95 percent of the metals in such discharges were eliminated due to Clean Water Act regulations. At the same time, the control systems required by these regulations were catching only 50 percent of the organics discharged to POTWs.[66] EPA recommended that continuation of the CWA programs " . . . can bring about major, additional reduction of organic substances."[67] In other words, despite past experience, it was concluded that the regulations based on pollution control would eventually work effectively to remove pollutants. There was no consideration given in the study to solving the problem by reducing the generation of hazardous wastes which are now being dumped into the sewage system.

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[61] *Inside E.P.A. Weekly Report*, vol. 7, No. 23, June 6, 1986.

[62] John P. Lehman, "Can Pollution Be Destroyed?" *EPA Journal*, April 1986, p. 10.

[63] Ibid. EPA has proposed spending over $75 million in fiscal year 1987 on a Hazardous Waste budget category called Regulations, Guidelines, and Policies. [U.S. Environmental Protection Agency, *Justification for Appropriation Estimates for Committee on Appropriations, Fiscal Year 1987, pp. HW-23 and HW-25.] A major component of that category is the development of the land disposal bans. Underway is the identification of best demonstrated available technology (BDAT) for classes of wastes banned from land disposal.*

[64] *U.S. Environmental Protection Agency, Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works* (Washington, DC: Office of Water Regulations and Standards, February 1986).

[65] 40 CFR Part 261.4(a)(ii). The regulation actually states that such mixtures are not *solid wastes*. However, due to RCRA regulations, a substance must first be judged a solid waste before it can be a hazardous waste.

In the EPA report to Congress on mine wastes, waste reduction *was* considered. The extraction and processing of minerals presents some unique problems for waste reduction. The objective in mineral extraction is to obtain as high as possible a concentration of the desired mineral, leaving behind waste tailings. When chemicals must be used to assist in the separation process, the EPA report points out that: "some changes in beneficiation processes can lead to changes in the chemical composition of the tailings released into tailings impoundments."[68]

Recycling Regulations

New RCRA regulations on recycled materials, which are often cited as disincentives to waste minimization, became effective in July 1985.[69] As discussed in chapter 1, it is difficult to determine precisely the difference between recycling as waste reduction and recycling as waste management. EPA explicitly excluded from regulation those recycling activities it determined *not* to be waste management practices.[70] In general, under the new regulations, recycled (used, reused, or reclaimed) materials are defined as solid wastes. As such, recycled materials can be subject to hazardous waste regulations under Subtitle C of RCRA. Special exemptions, however, allow waste reduction to occur outside of RCRA. A key exemption is materials " . . . recycled by being returned to the original process from which they are generated, without first being reclaimed."[71] If a material is first reclaimed before being returned to a process, a variance must be obtained to exempt that material from RCRA regulations.

A major benefit of waste reduction is avoiding the regulatory system since that which is not produced is not regulated. The recycling regulations can require a firm to apply for a variance if its waste reducing in-process recycling requires a reclamation step. While the variance procedure provides for regulatory escape, *it can also be a deterrent to waste reduction.* The need for a variance can also prod industry to consider alternate waste reduction approaches (such as changes in process technology and equipment, process inputs, and end products) which have less of an add-on or end-of-pipe character and may be more difficult to achieve technically.[72]

New regulations concerning the burning and blending of fuels and use of waste oils are also often cited as disincentives to waste minimization because they regulate practices that can reduce the use of land disposal. Depending on the circumstances, OTA considers the burning and blending of fuels to be, at best, a marginal waste reduction approach. Such regulations could indirectly and positively influence waste reduction decisions by increasing the cost of producing these materials.

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[66] Some of the chemicals released by industries are shifted to the air and land during transportation to POTWs. At the POTW, the received chemicals (loadings) are either destroyed or discharged to the air, land, and water. Of the substances received by the POTW group included in the study, 14 to 25 percent volatilizes to air, 43 to 62 percent biodegrades, 14 to 16 percent ends up in sludge, and 8 to 18 percent is discharged into surface water. [*Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works*, op. cit., p. 5-8.]

[67] Lee M. Thomas, Administrator, U.S. Environmental Protection Agency, POTW study transmittal letter to U.S. Congress, Feb. 7, 1986.

[68] U.S. Environmental Protection Agency, *Wastes from the Extraction and Beneficiation of Metallic Ores, Phosphate Rock, Asbestos, Overburden from Uranium Mining, and Oil Shale*, EPA/530-SW-85-033 (Washington, DC: Office of Solid Waste, December 1985), p. 3-5.

[69] The final rules were published in 50 Federal Register 614, Jan. 4, 1985. The regulations may be altered somewhat in 1987 by a lawsuit pending in the U.S. Court of Appeals in Washington, DC.

[70] 50 Federal Register 619, Jan. 4, 1985, Part I(III)(B) Secondary Materials That Are Not Solid Wastes.

[71] 40 CFR Part 261.29(e)(1). Reclamation is defined by RCRA as an activity that: " . . . involves the regeneration of wastes or the recovery of materials from wastes." [50 Federal Register 618, Jan. 4, 1985.]

[72] See ch. 3 of this report for a complete discussion of waste reduction approaches and the tendency of industry to concentrate on in-process recycling.

Small Quantity Generators (SQGs)

The 1984 RCRA Amendments brought into the system those firms generating between 100 and 1,000 kilograms per month of hazardous waste. The SQG regulations, finalized on March 24, 1986,[73] included two on waste minimization: manifest certification and the TSDF permitting condition. SQGs must now complete a portion of the biennial report but not the waste minimization section.

Most of the nonregulatory activities related to SQGs in RCRA have been outreach efforts to assure that such generators become aware of their new responsibilities. One method of doing so has been through the dispersal of RCRA Section 8001 grant funds via EPA Regional Offices to State and local governments and other nonprofit entities.[74] The fiscal year 1985 funds ($4.5 million), were not intended exclusively for SQG-related projects. They were in part to:

> . . . fund the development or implementation of State or local hazardous waste management efforts not directly permit-related but focused on innovative waste management activities, such as waste reduction, waste exchange, siting, use of alternatives to land disposal, shared treatment, and *assistance to small quantity generators*, which will reduce dependency on land disposal . . . [75]

However, the single largest group of projects that resulted and most of the funding went for SQG education and assistance projects. A review of the summaries of 80 such projects reveals that most dealt with compliance needs. Only three projects included waste reduction. The second set of funds (fiscal year 1986, $4.5 million) was awarded by the Regional Offices for projects based on the same guidance information as was provided for the previous year. For this reason, it is unlikely that waste reduction will become a higher priority during the second round of projects. It was expected that a large portion again will be directed at SQGs, as supporters again conducted an organized effort to obtain the funds.[76]

There was at least one possible win and one definite loss for waste reduction in the 1986 Section 8001 grants. Pennsylvania's Department of Environmental Resources was awarded $125,000 by EPA Region 3 to fund "hazardous waste source reduction" demonstration or pilot projects. Despite the fact that Pennsylvania's definition of source reduction is similar to OTA's waste reduction, the grants will be available for both waste reduction and waste management projects. The loss is a research and technical assessment program begun by Tennessee's Department of Economic and Community Development with fiscal year 1985 Section 8001 funds that will not continue. Tennessee had received $90,000 for Phase I of this program, which was matched by $10,000 in State appropriated funds. The department's request to EPA for 1986 funding for Phase II was denied by Region 4. One goal of the project had been to "reduce hazardous waste generation for 3 to 5 selected industrial categories by 20 to 50 percent." Both State projects are aimed at small and medium-sized business.

Clean Air Act (CAA)[77]

Federal responsibilities concerning industrial sources of air pollution have included the setting of National Ambient Air Quality Standards (NAAQS) for total suspended particulates, sulfur dioxides, carbon monoxide, nitrogen dioxides, ozone, and lead; the setting of National Emission Standards for Hazardous Air Pollutants (NESHAP); the imposition of new source performance standards (NSPS) on emissions from new stationary sources of pollution; and oversight for State programs which set up permitting systems to control actual emissions.[78]

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[73] 51 Federal Register 10146.

[74] The availability of these funds has been one of the reasons that State waste reduction programs have targeted such generators. See the discussion in ch. 6 of this report.

[75] U.S. Environmental Protection Agency, "Guidance on Use of Additional Appropriation for State and Local Activities," Attachment B to memorandum from Lee Thomas to all Regional Administrators, Dec. 13, 1984.

[76] Marty Madison, Office of Solid Waste, U.S. Environmental Protection Agency, personal communication, May 14, 1986.

[77] Although initial versions of the act date from the early 1960s, the Clean Air Act was passed essentially in its present form in December 1970 (Public Law 91-604) with additional amendments in 1977 (Public Law 95-95). Legislation was pending in the 99th Congress to amend the act.

The Clean Air Act begins, "Title I—Air Pollution Prevention and Control" and continues with Findings and Purposes, among which are:

> . . . that the *prevention and control* of air pollution at its source is the primary responsibility of States and local governments; and
>
> . . . that Federal financial assistance and leadership is essential for the development of cooperative Federal, State, regional, and local programs to *prevent and control* air pollution.[79]

Title I includes the stationary source provisions of the Clean Air Act, those that affect U.S. industry.[80] The phrase *prevention and control* appears throughout the first sections of the act. The Administrator is to encourage cooperative activities "by the States and local governments for the *prevention and control* of air pollution." A national R&D program is to be established for the *prevention and control* of air pollution.[81]

The Pollution Control Culture Under CAA

Unlike under the Clean Water Act, where pollution control has been the primary tool, both pollution control and prevention have been adopted under CAA. In the 1970s, initial actions by EPA concentrated on setting NAAQS. These environmental quality standards, which serve as the basis for individual plant emission limits determined at the local level, are now well established. Standards for numerous new sources and standards for six hazardous air pollutants have been promulgated. Unlike NAAQS, these latter two categories (NSPS and NESHAP) determine emission limits for individual sources of pollutants and can be industry-specific.

Conventional (Criteria) Pollutants.—The Air Quality Criteria and Control Technologies section[82] of CAA governs conventional pollutants. With the issuance of air quality criteria documents, which give the scientific basis for NAAQS, EPA is obligated to provide information to States and air pollution control agencies on "air pollution control techniques" related to specific air pollutants. However, such information must include data on " . . . available technology and *alternative methods of prevention* and control of air pollution. Such information shall also include data on *alternative fuels, processes, and operating methods which will result in elimination or significant reduction of emissions.*"[83] Thus, while the statute requires EPA to disseminate information on pollution control methods to meet the criteria, it is also supposed to accompany that information with alternative methods that include waste reduction approaches. (See ch. 3 for a discussion of waste reduction methods.)

New Source Performance Standards.—Section 111 of CAA requires EPA to set NSPS based on the "application of the best technological system of continuous emission reduction . . . the Administrator determines has been adequately demonstrated . . . " The technological system is defined by the statute in two ways. The first is a "technological process for production or operation by any source which is inherently low-polluting or nonpolluting" (i.e., a waste reduction approach). The second includes a pollution control approach or the pretreatment of fuels.[84]

As discussed in chapter 3, given the variety of industrial processes and operations in use it can be more difficult and expensive to prescribe *the best* (as the statute requires) technological system if it involves waste reduction rather than pollution control. Production processes can be plant-specific, whereas pollution control tends to involve generic systems applicable over a wide range of production processes.

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[78] EPA can also prevent significant deterioration (PSD) in selected regions where NAAQS are higher than ambient conditions and place limits on new emissions in nonattainment areas where NAAQS are not being met. Under CAA, EPA also deals with air pollution from mobile sources.

[79] Italics for emphasis. Section 101(3) and (4).

[80] Title II deals with mobile sources.

[81] Clean Air Act, Section 102(a) and 103(a).

[82] Ibid., Section 108.

[83] Ibid., Section 108(b)(1). Italics for emphasis.

[84] Ibid., Section 111(a)(1). Fuel pretreatment includes such techniques as "washing" coal to remove the sulfur prior to combustion. Depending on the fuel, the substance removed may be as hazardous as that which would be emitted after combustion. If so, a potential CAA problem most likely ends up as a RCRA or a CWA problem.

Hazardous Air Pollutants.—In setting hazardous air pollutant standards, EPA is directed to "issue information on *pollution control techniques* . . . "[85] The amendments to CAA passed in 1977 allowed EPA to promulgate "a design, equipment, work practice, or operational standard" when it is not "feasible to prescribe or enforce an emission standard."[86] This paragraph gives EPA the authority to set waste reduction standards for hazardous air pollutants. The Administrator can also allow the use of "alternative means of emission limitation" that will achieve a reduction in emissions equivalent to the emissions standard. This appears to give an individual generator the option of applying a waste reduction approach to meet the emission standards. The option could be unattractive to a generator, however, if a lengthy and costly procedure is required to obtain approval from EPA.

The history of hazardous (toxic) air pollutant regulations under CAA highlights many of the problems intrinsic to a pollution control scheme, especially one facing the regulation of potentially hundreds of substances.[87] Regulatory actions concerning hazardous air pollutants are defined and regulated under Section 112. This section is currently one of the most controversial parts of CAA. Of prime concern to many people is the slow way and the methodology by which hazardous air pollutants have been identified and studied and how the decisions regarding whether or not to impose emission standards have been made. Since Section 112 was added to CAA in 1970, 29 substances have received some kind of regulatory attention by EPA; emission standards for specific sources have been set for six of them by mid-1986.

In its 1985, "A Strategy To Reduce Risks to Public Health From Air Toxics,"[88] EPA outlined plans to move forward in regulating hazardous air pollutants. The major component of the plan, however, was to shift responsibilities to other Federal programs (such as FIFRA and TSCA) and to the State level. Few, if any, new ideas were presented; waste reduction was not considered.

While industry can be subjected to varying regulations by State and regional air control districts, the Federal list of regulated toxic substances under CAA is short, and standards are not comprehensive in terms of industry category or source. Substances that are not regulated can be emitted without limit. Not all emissions of a particular substance are covered; only specific, identified major sources are included. Benzene standards, for instance, apply so far only to fugitive sources (defined as various equipment, such as pumps, compressors, etc., "intended to operate in benzene service"). Any equipment at a site "designed to produce or use less than 1,000 megagrams of benzene per year" is exempt.[89] (One thousand megagrams is equal to 1 million kilograms or 1,000 metric tons.) Coke oven emissions standards (proposed in January 1986) are intended to control a variety of substances but only from wet charging and topside leaks.[90] The cost of setting NESHAP has been high. EPA has been working on the setting of benzene standards since 1977 and has categories other than the above yet to be determined. Expenditures—on this one substance—have totaled over $6 million through fiscal year 1985.[91]

Waste Reduction Under CAA

As the above shows, a legislative framework exists for the reduction—to complement the control—of hazardous air pollutants and also, to a lesser degree, of conventional air pollutants. NSPS explicitly allow waste reduction to be used for standard setting, but the language requiring a finding of *the best technological system* places a high burden on its use for that purpose.

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[85] Ibid., Section 112(b)(2). Italics for emphasis.

[86] Ibid., Section 112(e)(1).

[87] A new study, undertaken by OTA in 1986, will assess the regulation of hazardous air pollutants.

[88] U.S. Environmental Protection Agency, Washington DC, June 1985.

[89] 40 CFR 61.110 through 61.112, July 1, 1985.

[90] U.S. Environmental Protection Agency, "A Strategy To Reduce Risks to Public Health From Air Toxics," table I.

[91] U.S. Congress, General Accounting Office, *AIR POLLUTION: EPA's Strategy to Control Emissions of Benzene and Gasoline Vapor*, GAO/RCED-86-6 (Gaithersburg, MD: December 1985), p. 66.

The concept of reduction has been used under CAA. For example, sulfur dioxide emissions have been lowered in part by a switch to the use of lower-sulfur content coal. However, the NSPS for sulfur oxides for coal-fired utilities both sets a maximum allowable emissions rate and requires the removal of 70 to 90 percent of potential emissions *by technological means*. Thus, utilities are required to use pollution control scrubbers whether or not waste has been reduced at the source.[92] Under the NAAQS category the use of waste reduction has not been similarly overridden. Emissions of nitrogen oxides from existing combustion processes have been partially controlled by changing process operating conditions, such as combustion temperature.

On the other hand, for many of the industries subjected to CAA regulations, pollution control equipment may be more commonly used. In a document on control techniques for VOCs, EPA reported that there are two methods, end-of-pipe control and "changes in the process or raw materials," employed commercially to control VOC emissions.[93] Chapter 3 of the document contains 63 pages of general discussion on pollution control and two pages on waste reduction. Air pollution control devices such as electrostatic precipitators separate out rather than convert or destroy pollutants and baghouses collect particles contained in air streams. The resultant solids and sludges, if hazardous, are then shifted to the RCRA regulatory arena.[94]

The type of emission standard employed by EPA under NESHAP varies by substance and source. Operating standards have been applied (i.e., for asbestos use). For vinyl chloride, emission standards are stated either in concentrations (ppms) permitted to be released, which is conducive to the use of stack scrubbers, or in terms of allowable operating losses per product unit. The latter standard is more liable to promote waste reduction.

Innovation Waivers

Incentives to promote the development of innovative ways to control pollution were introduced into CAA by amendments to the act in 1977.[95] Waivers can be granted to both new and existing sources to delay compliance dates while new systems are being designed, installed, and tested. In both cases there must be a substantial likelihood that the new method will either reduce emissions below the regulatory standard or meet the standard at lower cost. Waste reduction could apply in either case but may have to be explicitly mentioned as a feasible alternative to be considered by regulators and industry.

According to a study conducted by the Department of Commerce in 1980, the waivers have failed to encourage industry to develop innovative technology.[96] The main reasons cited were lack of flexibility, confusion over the eligibility of technology, and inappropriate time limitations. (See also the following discussion of waivers under the Clean Water Act.)

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[92] See U.S. Congress, Office of Technology Assessment, *Acid Rain and Transported Air Pollutants: Implications for Public Policy*, OTA-O-204 (Washington, DC: U.S. Government Printing Office, June 1984), p. 141 and app. A to ch. 7.

[93] U.S. Environmental Protection Agency, "Control Techniques for Volatile Organic Compound Emissions From Stationary Sources," op. cit., p. 3-1. The stated purpose of this document is to comply with Section 108(b) of CAA (see above) which requires EPA to provide information on pollution prevention methods.

[94] A typical 1,000-megawatt powerplant scrubbing high-sulfur coal produces about 200,000 tons of sludge per year. [*Acid Rain and Transported Air Pollutants: Implications for Public Policy*, op. cit., p. 141.]

[95] The waiver provisions appear in Sections 111(j) and 113(d)(4) of the Clean Air Act.

[96] "Opportunities for Innovation: Administration of Sections 111(j) and 113(d)(4) of the Clean Air Act and Industry's Development of Innovative Control Technology," as cited by Nicholas A. Ashford, et al., "Using Regulation To Change the Market for Innovation," *Harvard Environmental Law Review*, vol. 9, 1985, pp. 419-466.

Clean Water Act (CWA)[97]

The Nation's current programs governing discharges to surface waters were set in 1972 by major amendments to the Federal Water Pollution Control Act. Among the policy and goal declarations in the statute are:

> . . . it is the national goal that the discharge of pollutants into the navigable waters be *eliminated* by 1985;
>
> . . . it is the national policy that a major research and demonstration effort be made to develop technology necessary to *eliminate* the discharge of pollutants . . . [98]

It is only physically possible to achieve the goal of elimination of discharges of pollutants by eliminating pollution at the source (i.e., waste reduction). Elimination from *the Nation's waters* can occur by using end-of-pipe treatment that shifts pollutants to another medium. This latter strategy of pollution control has been the guide for over a decade of emphasis on a system of controlled, sanctioned discharges designed to "restore and maintain the . . . integrity of the Nation's waters.[99] The second, interim goal of the statute has become guiding principle:

> . . . it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983;[100]

A basic premise of the Clean Water Act is that the only legal pollutant discharge is a regulated discharge. In all other cases, "the discharge of any pollutant by any person shall be unlawful."[101] Since 1972, technology-based regulations have been imposed on industrial plants in over 30 industrial categories and on publicly owned treatment works (POTWs). CWA splits dischargers into two groups: those who emit pollutants directly into surface waters and those who discharge indirectly through sewers to POTWs. The direct dischargers—both POTWs and industrial plants—are subject to permitting conditions under the National Pollutant Discharging Elimination System (NPDES). For this group, effluent limitations which set the maximum quantity or quality of pollutants that may be discharged are promulgated by EPA and are used to set specific permit conditions for levels of conventional pollutants, toxic pollutants, and nonconventional pollutants.[102] Indirect users of POTWs that have pretreatment programs, are subject to toxic pollutant pretreatment standards.[103] The discharge levels allowed under effluent limitations and by pretreatment standards vary among industrial subcategories and also by whether a discharge is a new or existing source of pollution.[104]

The Pollution Control Culture Under CWA

While EPA is instructed to " . . . prepare or develop comprehensive programs for *preventing, reducing, or eliminating* the pollution of the navigable waters and ground waters . . . ,"[105]

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[97] Throughout this discussion the terms Clean Water Act and CWA will be used, as is common, when referring to the Federal statute, the Federal Water Pollution Control Act (FWPCA). The latter act was originally passed in 1948 (Public Law 80-845) to which major amendments were made in 1972 by Public Law 92-500. The Clean Water Act is actually the name of the 1977 amendments (Public Law 95-217) to the Federal Water Pollution Control Act.

[98] FWPCA, Title I, Section 101(a)(1) and (6). Italics for emphasis.

[99] Ibid., Section 101(a). In some instances, like for the Paint and Ink Formulating category, the regulations [40 CFR Parts 446 and 447] require that no discharge of process wastewater be made. EPA justified this discharge ban by noting that most plants already comply by using solvent recovery, incineration, and contract solvent recovery [40 Federal Register 31724, July 28, 1975]. These are waste management approaches that can shift pollutants from navigable waters into other media.

[100] Ibid., Section 101(a)(2).

[101] Ibid., Section 301(a).]

[102] Conventional pollutants are biochemical oxygen demand (BOD), total suspended solids (TSS), pH, fecal coliform, and oil and grease. Toxic pollutants under CWA are more commonly called "priority pollutants." They are designated by Section 307(a)(1) of the act and listed in 40 CFR Part 401.15 as 65 classes of toxic pollutants which determine 126 specific materials. Most are organic chemicals; 13 are heavy metals.

[103] Indirect dischargers are also subject to General Prohibitions [40 CFR Part 403.5(a)] and Specific Prohibitions [40 CFR Part 403.5(b)]. These regulations prohibit pollutants that will "Pass Through or Interfere" with POTW operations and pollutants that will cause hazards (fire and explosions), corrosive damage, etc.

[104] The basic industrial categories (see 40 CFR 403, App. C) are broken down into several hundreds of subcategories. For a more comprehensive review of the CWA program, see U.S. Congress, Office of Technology Assessment, *Wastes in Marine Environments*, to be published in early 1987.

[105] FWPCA, Section 102(a). Italics for emphasis. The language, "prevention, reduction, and elimination" is also used in Sec-

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the use of control technology (primarily, wastewater treatment facilities) has primacy under CWA and in the way it has been implemented. An EPA publication, for instance, reports that:

> Categorical pretreatment standards for a given industry are based on the capability of a specific wastewater treatment technology or series of technologies to reduce pollutant discharges to the POTW . . . [106]

The following review of some of the statutory language reveals that EPA does have latitude in setting regulations under CWA. While control technology is stressed and often mentioned first, other options are given that point toward the use of waste reduction.

Effluent Guidelines.—The act set up a schedule so that limitations on direct discharges of pollutants were to be met in stages. The first, to be met by July 1, 1977, was based on "best practicable control technology currently available" (BPT). By July 1, 1984, a standard of the "best available technology economically achievable" (BAT) was to be applied, along with the use of "best conventional pollutant control technology" (BCT), to toxic pollutants in order to move toward the national goal of elimination.[107] In setting the various regulations, EPA must specify the factors taken into account in determining the "control measures and practices" applicable under BPT, BCT, or BAT; and the rigorousness of the application of the control concept varies under each. BPT and BCT factors are similar and include "total cost of application . . . engineering aspects of various types of control techniques, process changes . . . "[108]

The language defining BATs quite clearly includes waste reduction by calling for the "best control measures and practices achievable" including "treatment techniques, *process and procedure innovations, operating methods, and other alternatives*." Under BATs, EPA is to require the elimination of discharges of pollutants if, "the Administrator finds . . . that such elimination is technologically and economically achievable . . . "[109] To meet the first goal of the act, the statute specifies a fourth category of effluent limitations: the use of control measures and practices available to *eliminate* discharges.[110]

Standards.—The language covering pretreatment and performance standards also provides for the use of waste reduction. In the case of pretreatment standards for indirect dischargers, the "best available technology economically achievable" must be used to set effluent standards. A standard may prohibit any discharge. EPA is given the discretion to revise such standards as "control technology, processes, operating methods, or other alternatives change."[111] New source performance standards (NSPS) are to be achieved "through application of the best available demonstrated control technology, processes, operating methods, or other alternatives, including, where practicable, a standard permitting no discharge of pollutants."[113] EPA is also required to "issue information on the process, procedures, or operating methods that result in the elimination or reduction of the discharge of pollutants to implement standards of performance . . . "[114]

Neither the statute nor the regulations require that industrial facilities install the specific control technology on which limitations and standards are based. They must, however, achieve discharge limits that EPA determines are possible using the model technology.[114] In fact, the

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tion 101(b) in reference to congressional policy regarding rights of States in operating water quality programs and regarding support for research.

[106] U.S. Environmental Protection Agency, *Guidance Manual for the Use of Production-Based Pretreatment Standards and the Combined Wastestream Formula* (Washington, DC: Permits Division and Industrial Technology Division, September 1985), p. 1-2.

[107] FWPCA, Sections 301(b)(1)(A), 301(b)(2)(A), and 301(b)(2)(E). The statute imposed deadlines on the dischargers. Therefore, Congress intended EPA to have the regulations in place sufficiently ahead of these dates to allow for compliance.

[108] Ibid., Section 304(b)(1)(B).

[109] Ibid., Section 301(b)(2)(A). Italics for emphasis.

[110] Ibid., Section 304(b)(3).

[111] Ibid., Section 307(b)(2).

[112] Ibid., Section 306(a)(1).

[113] Ibid., Section 304(c).

[114] U.S. Environmental Protection Agency, *Guidance Manual for the Use of Production-Based Pretreatment Standards and the Combined Wastestream Formula*, op. cit., p. 1-3.

use of the model technology does not assure that a facility is in compliance with the regulations.[115] However, the technical Development Documents that support each regulation and the preamble to the regulations published in the *Federal Register* identify the technology used to set the limitations or standards. It seems obvious that a firm being subjected to new regulations would opt to use the identified technology rather than spend time and money devising an alternative. Thus, despite flexibility in the statute and the explicit mention of alternatives to pollution control, the system that has evolved under CWA inhibits the adoption of waste reduction by industry.

Innovation Waivers

A section was added to CWA in 1977 to induce industry to adopt innovative measures. An administrative procedure was set whereby facilities subject to NPDES permits (direct dischargers) could apply for an extension of time (up to 3 years; until July 1, 1987) before complying with BAT regulations. This Section 301(k) specifies three categories of acceptable alternative methods for meeting the regulations and gaining the time waiver: 1) replacing existing production capacity with an innovative production process, 2) installing an innovative control technique, or 3) achieving the required reduction with an innovative system to significantly lower costs beyond those determined by EPA to be economically achievable. To qualify, the first two must result in an effluent reduction significantly greater than that required by the regulations and move toward the national goal of elimination. In all cases, the technology must be judged as having the potential for industrywide application. Waste reduction approaches could apply under the first and third categories, but there is no evidence of its use under this section.

Only a handful of applications for the waivers have ever been received by EPA headquarters.[116] Three waivers for better control techniques were granted by EPA Region 5 to steel firms and only one of these was ultimately used. One was unused because the plant was closed. In the second case, the existing treatment process was modified to comply with the BAT regulation making the innovative process unnecessary.[117] In Region 3, two applications were received and one waiver has been granted. As in Region 5, the grantee was a steel firm that proposed an innovative control technology that qualified because of lower cost.[118]

Several factors could account for the seeming unattractiveness of this waiver provision to industry. Among them are: 1) a possible lack of knowledge among direct dischargers that the provision exists; 2) a feeling in industry that the uncertainty of outcome is not worth the cost of applying, since either *significant* discharge or cost reductions must be proven; and 3) the value of the reward (a 3-year extension) is low. Because little or no compliance enforcement occurs under the NPDES, a similar "extension" is available to all dischargers whether or not they bother to go through the waiver process.[119] In addition, regulations were not written for all industrial categories by the BAT statutory deadline of July 1, 1984, so many potential applicants are essentially ineligible for the waiver that will expire in 1987.

A Model for Waste Reduction Standards or Guidelines

Examination of the effluent limitation guidelines and the performance and pretreatment standards process that has evolved under the Clean Water Act provides an opportunity to foresee what a prescriptive waste reduction program might be like. The process under the Clean Water Act has been lengthy, contentious, and expensive. **The following discussion shows that setting waste reduction standards could be more complex, take more time, and be more costly.** If resources were sufficient and industry, government, and environmental organizations worked cooperatively, these complications of setting waste reduction standards might be dealt with effectively over time.

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[115] Marvin Rubin, Industrial Technology Division, U.S. Environmental Protection Agency, personal communication, June 16, 1986.

[116] Marilyn Goode, Permitting, U.S. Environmental Protection Agency, personal communication, June 16, 1986.

[117] Gary Amendola, Eastern District Office, Region 5, U.S. Environmental Protection Agency, personal communication, June 17, 1986.

[118] Terry Oda, Permiting and Enforcement, Region 3, U.S. Environmental Protection Agency, personal communication, June 18, 1986.

[119] U.S. Congress, General Accounting Office, *Wastewater Dischargers Are Not Complying With EPA Pollution Control Permits*, GAO/RCED-84-53 (Gaithersburg, MD: Dec. 2, 1983), p. 42. Also see OTA's *Wastes in Marine Environments*, op. cit.

The setting of regulatory standards under the Clean Water Act began in 1973 and is still in process. By March 1979, EPA had not even *proposed* BAT guidelines for any industrial categories[120] although the 1972 act required dischargers to comply by July 1, 1983. While many of the BAT regulations for direct dischargers have now been promulgated, some of these are still not in effect because of lawsuits that have not been concluded. After numerous delays, the regulations for the organic chemicals and plastic manufacturing industry category—originally proposed in 1983—are under court order to be finalized by December 1986. Some of the pretreatment standards, although promulgated, are still not in effect; some (notably for the organic chemical industry) are not yet set (see table 5-5). The annual budget for the Effluent Standards and Guidelines program at EPA that sets the regulations peaked at $28.2 million for fiscal year 1981 and totaled $144 million from fiscal year 1979 through 1986. The requested budget for fiscal year 1987 is $6.2 million. As the cost of research is not included in these figures, the true cost to the Federal Government of setting regulations under the Clean Water Act is considerably greater. When government costs peaked in 1981, U.S. industry spent $14 billion on water pollution abatement and control.[121]

As mentioned above, the regulations differ by industrial categories and subcategories because of the many differences in processes, waste streams, and economics that must be taken into account.[122] These differences made it necessary for EPA to gather industry-specific data on raw materials, final products, manufacturing processes and operating costs, equipment, age and size of plants, water usage, wastewater discharge, treated effluent characteristics, the sources and volume of water used, the sources of pollutants and wastewaters, the amount of raw waste, the constituents of wastewaters, and maintenance operations and costs. The analysis of each industry category based on the collected information and data is published in Development Documents, which serve as the support for the proposed regulations.

Table 5-5.—Status of Clean Water Pretreatment Standards by Industrial Category

	Final regulations	
Industry category	Promulgation date	Compliance date
Aluminum forming	10/24/83	10/24/86
Battery manufacturing	03/09/84	03/09/87
Coil coating	12/01/82	12/01/85
Coil coating (can)	11/17/83	11/17/86
Copper forming	08/15/83	08/15/86
Electrical components I	04/08/83	11/08/85
Electrical components II	12/14/83	07/14/86
Electroplating	01/28/81	06/30/84
	07/15/83	07/15/86
Inorganic chemicals I	06/29/82	08/12/85
Inorganic chemicals II	08/22/84	06/29/85 08/22/87
Iron and steel	05/27/82	07/10/85
Leather tanning	11/23/82	11/25/85
Metal finishing	07/15/83	06/30/84 07/10/85 02/15/86
Metal molding and casting	10/08/85	10/31/88
Nonferrous metal forming	08/23/85	08/23/88
Nonferrous metal manufacturing I	03/08/84	03/09/87
Nonferrous metal manufacturing II	09/20/85	09/20/88
Pesticides	10/04/85	10/18/88
Petroleum refining	10/18/82	12/01/85
Pharmaceuticals	10/27/83	10/27/86
Plastics molding and forming	12/17/84	None
Porcelain enameling	11/24/82	11/25/85
Pulp, paper, paperboard	11/18/82	07/01/84
Steam electric	11/19/82	07/01/84
Textile mills	09/02/82	None
Timber products	01/26/81	01/26/84
Organic chemicals	[a]	None
Plastics/synthetics	[a]	None

[a] Under court order to promulgate standards by December 1986.

SOURCE: U.S. Environmental Protection Agency, Report to Congress on the Discharge of Hazardous Wastes to Publicly Owned Treatment Works (Washington, DC: Office of Water Regulations and Standards, February 1986), pp. 6-59.

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[120] U.S. Congress, General Accounting Office, *Wastewater Dischargers Are Not Complying With EPA Pollution Control Permits*, op. cit., p. 38.

[121] U.S. Department of Commerce, "Pollution Abatement and Control Expenditures," *Survey of Current Business*, March 1985.

[122] See Margherita Pryor, "Fighting Water Toxics With Effluent Guidelines," *EPA Journal*, September 1985, pp. 8-10.

The final result of these efforts is a complex array of regulations. Three different limitations can be set—based on BPT, BAT, and BCT—for all regulated direct discharging industries, performance standards have been adopted for some new sources, and two sets of standards—one for existing and one for new sources—are being set for the regulated indirect dischargers. The existing regulations cover 1,102 pages in the *Code of Federal Regulations*.[123]

The CWA regulatory structure and the procedure that produces it is simple, however, compared to the effort that would be required to regulate waste reduction. Under CWA, once processes producing polluting streams were analyzed, a discrete set of feasible end-of-pipe technologies could be identified and tested against the economic criteria set forth in the statute. Next, one model technology was chosen to provide the basis for the limitations or standards.

It is not possible to determine one model technology for waste reduction. OTA has defined five categories of possible waste reduction approaches (which are discussed fully in ch. 3). For each process or operation identified as a producer of hazardous waste, therefore, one or all five categories could be applicable and within each category a very large number of approaches might also be possible. While the actual approach to be adopted could be left up to a specific plant to determine, government would need to analyze the possible approaches in order to determine an equitable *level* of reduction that could then be required and enforced for specific processes or operation within a specific industry.[124] Moreover, it is not clear that generic waste reduction approaches can be applied across plants within specific industries. In other words, many processes and operations can be *plant*-specific. In addition to the problems of matching production processes to reduction approaches, an effective waste reduction program needs a multimedia approach. Standard setting under such a program would require the consideration of all hazardous waste generating processes as well as potential shifts across media.

As discussed in chapter 4, the data and information that EPA has collected under the water program is out of date and is, therefore, not relevant for setting future standards for waste reduction. Comparable information has not been collected for air emissions nor for RCRA discharging industries and processes. Thus, the first stage of a prescriptive waste reduction program would be a lengthy and expensive process of collecting information and data.

Toxic Substances and Control Act (TSCA)[125]

Through TSCA, EPA has the authority to deal with many aspects of a chemical's lifecycle. The statute covers a broad category of chemical substances and mixtures[126] and is one of two environmental statutes that deals with the production of chemicals as well as the effects of their use.[127] Of major relevance to waste reduction is the prevention concept embodied in TSCA.

In enacting TSCA, Congress was concerned that:

> . . . among the many chemical substances and mixtures which are constantly being developed and produced, there are some whose manufacture, processing, distribution in commerce, use, or disposal may present an unreasonable risk of injury to health or the environment . . . [128]

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[123] 40 CFR, July 1, 1985.

[124] Under the Metal Finishing Category in the water program EPA identified 46 unit operations. The first six were called core operations and a facility has to perform at least one of them in order to be subject to pretreatment standards for metal finishers. Many of the 46 might offer a potential for hazardous waste reduction. [U.S. Environmental Protection Agency, *Guidance Manual for Electroplating and Metal Finishing Pretreatment Standards* (Washington, DC: Effluent Guidelines Division and Permit Division, February 1984), p. 3-2.]

[125] Public Law 94-469 enacted on Oct. 11, 1976.

[126] TSCA, Section 3(2)(A), defines chemical substances as "any organic or inorganic substance of a particular molecular identity." Exempted from coverage under TSCA are pesticides, tobacco or tobacco products, materials covered by the Atomic Energy Act of 1954, and "any food, food additive, drug, cosmetic, or device . . ."

[127] The other statute is FIFRA which regulates the production and use of pesticides.

[128] TSCA, Section 2(a)(2).

The statute provides the government with the authority to require manufacturers to develop and submit data on the chemical substances they produce or intend to produce. During its 10 years, the Office of Toxic Substances (OTS) has generated an inventory of over 62,000 chemicals produced or imported as of 1977. This list provides the basis for the Pre Manufacturing Notice (PMN) system whereby manufacturers must notify EPA at least 90 days in advance of their intent to produce a new chemical substance.[129] In fiscal year 1984, 1,192 PMNs were received. After review, OTS gave permission for 1,036 (86 percent) of these chemicals to be produced. OTS took some action (regulation or further review) on 116 (10 percent). The balance were withdrawn.[130]

EPA can regulate chemicals under TSCA in a variety of ways. It can prohibit or limit the "manufacture, processing, distribution in commerce, use, or disposal" of a chemical judged to present "an unreasonable risk of injury to health or the environment." It can also alert users to potential risk by requiring that "any article containing such substance or mixture be marked with or accompanied by clear and adequate warnings and instructions."[131]

OTS can refer chemicals to other agencies for action, removing them from regulation under TSCA. For instance, after concluding that 1,3-butadiene was a probable human carcinogen, a referral was made to OSHA in 1985 for consideration of "engineering controls or personal protective equipment" to reduce the cancer risk to which thousands of workers are exposed.[132]

The potential for regulating chemicals under TSCA is greater than its implementation so far. In its first 7 years, EPA issued regulations on four existing chemicals: 1) the manufacture, processing, and distribution in commerce of polychlorinated biphenyls (PCBs) was prohibited, as had been required by the statute; 2) nonessential uses of chlorofluorocarbons were banned; 3) the disposal of dioxin was controlled; and 4) the inspection of schools for asbestos was required. As of early 1986, regulations were under consideration for a number of existing chemicals.

While the TSCA program has subjected industry to extensive reporting and recordkeeping procedures on specific chemical substances, most of the information collected has been labeled as confidential business information by the manufacturers. Chapter 4 in this report discusses the information collected under TSCA and concludes that, because of the number of limitations placed on what information can be collected as well as the confidential nature of much of this information, this function of TSCA would be of marginal use for a Federal waste reduction program and perhaps of even less value if such a waste reduction program were delegated largely to the States.

Some proponents of waste reduction point to TSCA as the appropriate environmental statute under which to operate a waste reduction program. The slow pace of activity under both TSCA and FIFRA, however, points out a difficulty of relying on regulating chemicals at the raw material stage. The sheer numbers of chemicals and the changes in chemicals produced for raw material use can easily overwhelm any government attempt to thoroughly, equitably review and assess chemicals prior to their use. The General Accounting Office has estimated that it will take the FIFRA program the next 20 years to complete its reregistration of existing pesticides.[133]

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[129] *New* being defined as either not being on the existing inventory list or a "significant new use" of a chemical on the list.

[130] Council on Environmental Quality, *Environmental Quality 1984, 15th Annual Report* (Washington DC: U.S. Government Printing Office, 1984), p. 194.

[131] TSCA, Section 6(a) and 6(a)(3). A judgment of "unreasonable risk" is a balancing process between health and environmental effects, exposures, and economic value of a chemical, according to EPA. [Don R. Clay, "Issues in Toxics Control," *EPA Journal*, June 1985, p. 4.]

[132] *Hazardous Materials Intelligence Report* (Cambridge, MA: World Information Systems, Jan. 10, 1986), p. 4.

[133] U.S. Congress, General Accounting Office, *PESTICIDES: EPA's Formidable Task To Assess and Regulate Their Risks*, GAO/RCED-86-125 (Gaithersburg, MD: April 1986), p. 20.

Superfund[134]

Superfund has been a major influence in convincing industry to change traditional waste management practices. The act is also cited as an inducement to firms to undertake waste reduction because of its taxing and liability provisions. In combination with RCRA, liabilities assessed to generators who can be named as parties responsible for creating Superfund sites can be high. This potential cost of doing business is now becoming a part of investment calculations in major corporations.

In addition to having these indirect impacts, provisions calling for citizens right to know and the establishment of a national chemical inventory in the U.S. House of Representatives and Senate Superfund reauthorization bills are relevant to waste reduction.[135] Implementation of the right-to-know provision would increase the awareness of people working in a plant about hazardous substances in the plant and, thus, act as an incentive for waste reduction practices. Information about the presence of substances within a community can also increase public pressure on industries to consider waste reduction as an alternative to waste management.

A national chemical inventory could directly benefit a Federal waste reduction program, primarily as a tool to identify priorities. The current legislation suggests a plant-level inventory in which chemical input and outputs are identified. As discussed more fully in chapter 4, aggregated plant-level information leaves many questions unanswered about whether waste reduction is actually occurring. It can, however, provide information essential for setting directions and priorities for waste reduction program components such as information and technology transfer, education, and generic R&D.

RESEARCH AND DEVELOPMENT, INFORMATION AND TECHNOLOGY TRANSFER

A number of existing agencies of the Federal Government could provide substantial support to U.S. industry in its efforts to prevent environmental pollution. Government actions could include evaluating generic process operations, engaging in industrial process R&D, and information and technology transfer. But, little such support is offered today that is relevant to waste reduction. EPA—the obvious lead agency—spends less than 1 percent of its R&D budget on waste minimization. Research organizations desiring to work on waste reduction find it difficult, if not impossible, to obtain funding because of the lack of importance given waste reduction by government and industry.

Most of the work that is conducted by the Federal Government is primarily directed at the internal needs of agencies. Most work labeled waste minimization has a minor waste reduction component. EPA has a small technology evaluation contract underway, makes some grant funds available to small firms and academia, and has helped to fund some State research grant programs. The Department of Energy is informally incorporating waste reduction into its waste management program at one major facility. The Department of Defense has developed a formal waste minimization program to help control its extensive waste generation problems. The Tennessee Valley Authority offers some regional technical and information support. Information programs on hazardous materials are managed by the Occupational Safety and Health Administration in the Department of Labor. There is no coordination of these activities other than that which occurs within EPA between its Office of Solid Waste and Office of Research & Development.

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[134] Superfund is the common name for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Public Law 98-510, December 1980. Reauthorization of Superfund may occur in 1986 in the 99th Congress.

[135] As this report was going to press, Congress had finished its conference committee deliberations on new Superfund legislation. Details of the final bill, however, were not available in time to include them here.

Many opportunities exist, however, within the existing mandates of these and other agencies and programs to increase support for waste reduction. Federal agencies, such as the Bureau of Mines, the National Bureau of Standards, and the National Science Foundation, could lend additional support to U.S. industry. Doing so, which would avoid the cost of setting up new programs, would not be productive, however, without the establishment of a modest Federal waste reduction program to provide policy drive, guidance, and coordination.

Research and Development at EPA

Waste **minimization** research and development is a low-priority item within EPA. It received about $1.2 million—half of 1 percent of EPA's fiscal 1986 estimated $213.8 budget for all R&D. The waste minimization estimate of $1.2 million is derived from portions of the expenditures of EPA's Hazardous Waste Engineering Research Laboratory, EPA funds budgeted for the Center for Environmental Management at Tufts University in Massachusetts, and EPA funds granted to the Industrial Waste Elimination Research Center in Illinois.[136] (In ch. 6 of this reort, table 6-2 identifies State waste reduction programs that have received additional EPA funds.)

OTA estimates that *much less* than 50 percent of EPA's funding for waste minimization R&D applies to waste reduction, even though the agency has identified waste reduction as one of two categories of waste minimization. For EPA's report to Congress, $500,000 was spent for contract reports that reviewed the state of existing technology for waste reduction and recycling. Current work within EPA continues in the same vein, assessing and collecting information; no technology R&D is being conducted. (Waste reduction R&D options are presented by OTA in ch. 2 and technology is discussed in ch. 3.)

As has happened elsewhere within EPA, waste reduction has become a minor tool in the agency's search for alternatives to land disposal. In the April 1986 issue of *EPA Journal* in an article about research at EPA that seeks to "break the land disposal habit," waste reduction is mentioned as one of four "major alternatives," along with materials recovery, energy recovery, and waste treatment. Over two-thirds of the article is devoted to waste treatment activities at EPA; in the section on waste reduction there is a brief mention of the fact that some private sector initiatives exist and that as economic conditions change more waste reduction will take place.[137]

Proposals for future R&D efforts do not indicate a change in emphasis. Waste treatment continues to receive high priority. In drawing up its justification for a $36 million request for hazardous waste R&D for fiscal year 1987, the closest EPA came to mentioning waste minimization was in plans to continue to evaluate "both new and existing alternative treatment processes for wastes likely to be banned from land disposal."[138] Such alternative treatment processes could include recycling, but will not reduce the generation of hazardous waste at the source.

Internal and Contract Research.—The Hazardous Waste Engineering Research Laboratory (HWERL) is one of three research laboratories in the Office of Environmental Engineering & Technology.[139] Despite claims that HWERL "is working to foster increased use of . . . waste reduction . . . ,"[140] OTA could find little work specifically directed toward this objective. The

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[136] EPA R&D budget numbers are taken from its *Justification for Appropriation Estimates for Committee on Appropriations, Fiscal Year 1987.*

[137] John H. Skinner, "Research to Break the Land Disposal Habit," *EPA Journal*, vol. 12, No. 3, April 1986, pp. 12-14.

[138] EPA Budget Justification Document, op. cit., p. HW-18.

[139] The laboratories are set up by media; the other two are the Air & Energy Engineering Research Laboratory and the Water Engineering Research Laboratory.

[140] Skinner, op. cit., p. 12.

Alternative Technologies Division of the laboratory has responsibility for waste minimization research. A series of case histories on recycling opportunities has been completed and will be published in 1986. Funding for waste minimization for fiscal year 1986 is $235,000 (2 percent of the division's total budget) and is being used for one contract.

The aim of this single waste minimization project is to develop a standard waste audit procedure that could be used throughout industry to identify waste minimization opportunities. The current project will test the applicability of a waste audit procedure developed by the contractor to five different facilities that generate large amounts of RCRA wastes that are slated to be banned from land disposal. Problems will be identified and improvements proposed (recycling or waste reduction) at each facility. A followup project is under consideration to determine whether the proposals are actually adopted and whether they are successful.

Waste audits, in various forms, are used by industry today and have become one of the services offered by engineering consultants (see ch. 3). EPA's funding to test the applicability of a model waste audit appears to be primarily internally directed. For instance, a model procedure has potential as a regulatory tool (for the analysis of waste minimization plans). Or, if EPA decides to institute a waste minimization grants program, a standardized waste audit could serve as a required feasibility step to aid in the analysis of proposals.[141] EPA is not conducting, and has no plans to conduct, technology R&D related to either recycling or waste reduction. Such research—generic or specific—is viewed as being more appropriate for industry itself to conduct, especially given the small amount of government budgets available for waste minimization.[142]

Future spending on waste minimization by EPA is only due to increase slightly and will continue to be used for technical analyses with potential for information transfer. In an overall planning document outlining the fiscal year 1988 R&D budget for RCRA hazardous waste, waste minimization is not identified by EPA officials as a "hazardous waste strategic issue area" for which a budget is recommended.[143] Neither waste minimization nor waste reduction is included among the issue areas identified. In a research plan document reviewing the Alternative Technology Division's future budget needs, waste minimization is included as one of five major research objectives.[144] The budget plan for waste minimization for fiscal year 1989 calls for an increase from the present 2 percent to 4 percent of the division's total budget. It is apparent that future budgets, like current budgets, will continue to concentrate on waste treatment. One discussion point in the research plan suggests supplemental funding to support a program on potential waste minimization reuse and recycle regulations. The amount suggested for this project would grow from $400,000 in fiscal year 1987 to $500,000 in 1990 and amounts to a tripling of the division's current waste minimization budget. No supplements are suggested for waste reduction research.

The Alternative Technology Division's research plan was reviewed by the EPA Science Advisory Board. The board recommended that waste minimization research be "significantly strengthened." Methods suggested by the board included increasing the proportion of the division's research funds dedicated to waste minimization, placing more emphasis on waste reduction (as opposed to the division's concentration on recovery and reuse of waste materials), and establishing a formal network between industry, academia, and government to improve the transfer of information.[145]

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[141] Harry Freeman, Research Program Manager, Alternative Technologies Division, Hazardous Waste Engineering Research Laboratory, U.S. Environmental Protection Agency, personal communication, July 8, 1986.

[142] Ibid.

[143] U.S. Environmental Protection Agency, Office of Research and Development, memorandum from the Hazardous Waste/Superfund Research Committee (Meg Kelly and John Skinner) to Donald J. Ehreth (Acting Assistant Administrator for Research and Development) and J. Winston Porter (Assistant Administrator for Solid Waste and Emergency Response), Apr. 23, 1986.

[144] U.S. Environmental Protection Agency, Office of Research and Development, memorandum "Alternative Technology Review (Step 2)," from Alfred W. Lindsey (Acting Deputy Director, Office of Environmental Engineering & Technology), to the Hazardous Waste Research Subcommittee, June 16, 1986.

Research by Grants Funding.—There are three programs within the Office of Exploratory Research that handle EPA's unsolicited grants and university research: the Research Centers Program, the Research Grants Staff, and the Small Business Innovation Research (SBIR) Program. Since the research centers' work is determined by EPA needs, little attention has been given to waste reduction or even waste minimization. A small percentage of the research funded by grants and the SBIR program has dealt with waste reduction in the past. If the issue of waste reduction increases in visibility, these two programs as now constituted have the potential of providing more funding—for research by nonprofit entities and small businesses. Waste reduction, however, will need to be placed explicitly on suggested proposals lists and given prominence during award procedures. Accordingly, the persons involved both in determining the lists and judging the proposals submitted will need to be cognizant of waste reduction. Neither of these programs offers funding assistance to the bulk of industry, which may be the most relevant place for development of waste reduction techniques.

The **Research Centers Program** oversees activities at the eight EPA Centers of Excellence set up in 1979 to provide EPA with an improved basic research capability. Each center—located at a university—receives $540,000 per year from EPA's R&D budget and is expected to supplement its income from other public and private sector sources. The centers do not focus exclusively on hazardous waste.

The Industrial Waste Elimination Research Center, established in 1980 as a joint project of the Illinois Institute of Technology and the University of Notre Dame, is the EPA center where work is most directly related to waste reduction. Its annual budget is based on the EPA grant and is supplemented occasionally by funds given by public or private interests for specific projects. The center's mission is to pursue basic research applicable to environmental problems that have been identified by EPA. Specific projects have focused on the chemistry of metal recovery and adsorption of organics from liquids and vapors. Both of these recovery techniques could have applicability to waste reduction if they are incorporated into manufacturing processes. The center would like to pursue waste reduction more directly but does not do so because the subject lacks priority at EPA. It also finds there to be little industrial support for waste reduction research because neither environmental regulations nor economic factors are sufficiently compelling to force an interest.[146]

Within the 1986 Superfund legislation is an authorization for the establishment of 5 to 10 regional University Hazardous Substance Research Centers at an annual cost of $5 million. These centers—which could replace the Centers for Excellence—are to conduct "research and training" relating to the "manufacture, use, transportation, disposal, and management" of hazardous substances.[147] Such a legislative mandate is broad and could be interpreted to include research relating to waste reduction. However, without a specific mention of waste reduction or waste minimization in the legislation, the likelihood that such research will occur is poor, given the inclination of EPA to place such items low on its agenda.

Through the **Research Grants** Office, annual funding is awarded to nonprofit institutions and State and local governments primarily for basic research. The total research grants budget for fiscal year 1986 is $10.8 million. (This amount will decrease to about $7 million in the budget requested by EPA for fiscal year 1987.)[148]

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[145] U.S. Environmental Protection Agency, "Review of the Alternative Technologies Research Program," report of the Environmental Engineering Subcommittee of the Science Advisory Board, July 1986.

[146] Charles Haas, Industrial Waste Elimination Research Center, personal communication, May 23, 1986.

[147] The language quoted comes from Research and Development paragraphs in an undated Superfund conference draft. As this report was going to press, Congress had finished its Superfund conference committee deliberations but details of the final bill were not available in time to include them here. Hazardous substances are defined under Superfund (CERCLA) and include RCRA hazardous wastes, hazardous air pollutants listed under Section 112 of Clean Air Act, toxic pollutants regulated under Section 307(a) of Clean Water Act, and imminently hazardous chemical substances under Section 7 of TSCA.

Proposals for projects are submitted based on a list of four program areas of interest to EPA: environmental biology, health, engineering, and air/water chemistry and physics. For the 1986 award cycle, waste reduction projects were explicitly mentioned as an area of interest under wastewater treatment and pollution control within the environmental engineering program area. They are defined as: "In-plant unit process operations minimizing or eliminating toxics generation and release to the environment."[149] Similar solicitation was not suggested under the air pollution control category; there is no comparable category for RCRA hazardous wastes.

No projects that could be considered relevant to industrial waste reduction were awarded research grants in 1985; however, two dealt with reducing the use of chlorine in and the formation of toxic byproducts from the disinfection of drinking water.

The **SBIR program** is mandated by the Small Business Innovative Development Act of 1982[150] and, under that act, is entitled to at least 1 percent of EPA's R&D outside contract funds. In fiscal year 1986 the program's funds amounted to about $2.6 million.[151] Contracts are awarded in two stages. Phase I funding is used to show the scientific and technical merit and the feasibility of a proposal. Phase II funding is intended to move the Phase I innovation toward commercialization.

As in the procedure under the grants programs, prospective SBIR bidders receive a list of broad topics of interest to EPA. For the 1986 cycle of awards, the topics are: drinking water treatment, municipal and industrial wastewater treatment and pollution control, biological sludge treatment for improved handling and disposal, solid and hazardous waste disposal and pollution control, mitigation of environmental pollution problems, air pollution control, and environmental monitoring instrumentation. While neither waste minimization nor waste reduction appears as a topic area, the concept of waste reduction appears as a suggested "area of interest" under the wastewater treatment and pollution control topic and under solid and hazardous waste disposal and pollution control.

Fifty-one Phase I and II projects were funded by EPA between 1983 and 1985. A review reveals that five waste reduction projects were included in 40 Phase I awards over that time; one of these waste reduction projects advanced to Phase II.

Small business firms may also be able to obtain assistance directly from the Small Business Administration for waste reduction projects (see box 5-A).

Other Environmental R&D Organizations

A number of States or universities have established hazardous waste research facilities. Some receive financial assistance from EPA or other government agencies; some do contract work for EPA. Overall, they now conduct relatively little waste reduction research, but they would do more if the need were recognized and funding made available. Four such existing organizations are highlighted in table 5-6 and discussed briefly below. A Research and Development Center for Hazardous Waste Management has been proposed for the State of New York.

The Industry/University Cooperative Research Center for Hazardous and Toxic Waste at the New Jersey Institute of Technology takes a multimedia approach in its research but concentrates on end-of-pipe solutions. According to the director, the center's mission to conduct research in treatment technologies at the

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[148] Clarice Gaylord, Program Manager, Research Grants Office, U.S. Environmental Protection Agency, personal communication, May 23, 1986.

[149] U.S. Environmental Protection Agency, *Solicitation for Research Grant Proprosals*, EPA/600/8-85/021 (Washington DC: September 1985), p. 9.

[150] Public Law 97-219. This legislation includes a sunset provision that comes due Oct. 1, 1988. The House of Representatives passed a bill—H.R. 4260, Small Business Innovation Research Program—on Aug. 12, 1986, to extend the program through 1993. Up to that time, the Senate had not acted on SIBR reauthorization.

[151] Walter H. Preston, Program Manager, Small Business Innovation Program, U.S. Environmental Protection Agency, personal communication, May 23, 1986.

Box 5-A.—Small Business Waste Reduction Funding Assistance

The Small Business Administration (SBA) offers a wide range of loan programs to small business firms. In the environmental area the prime SBA loan vehicle is a Pollution Control Financing Guarantee (PCFG) authorized under the Small Business Investment Act.[1] So far, no applications have been received by SBA for any waste reduction projects. Consistent with what OTA has repeatedly found elsewhere, the PCFG program has been viewed by those outside and within SBA as a way to support traditional pollution control activities. The Small Business Ombudsman at EPA, however, has recognized its potential to assist its constituency by advancing waste minimization projects and has been trying to work with SBA to expand the program.[2]

PCFGs should be applicable to waste reduction projects. A small business firm can apply to SBA for this loan guarantee if private financing is denied or if it is granted, but at a rate not comparable to those granted to other business concerns, "with respect to the planning, design, or installation of pollution control Facilities . . ."[3] The statutory definition of a facility has been interpreted as one that is likely to:

> . . . prevent, reduce, abate, or control noise, air or water pollution; or eliminate contamination by removing, altering, disposing, or storing pollutants, contaminants, waste, or heat; or provide for the collection, storage, processing, treatment/utilization, or final disposal of solid or liquid waste, including any related resource recovery property.[4]

Other general SBA loan programs could also apply to waste reduction projects. These alternative programs, however, are less favorable. They do not carry a fixed interest rate, are for a shorter term than PCFGs (maximum 7 years rather than 15), are only 75 percent (vs. 100 percent) guaranteed by SBA, and are applicable only when financing has been denied in the private market.

Loan programs that emphasize the need for capital costs can promote the application of more costly waste reduction approaches. As discussed in chapter 3, waste reduction can often be achieved by simple, relatively inexpensive methods such as changing operating procedures of existing facilities or instituting better housekeeping methods around a facility. Since waste reduction approaches improve the overall operation of industrial processes, it can be difficult to draw a line between a change for waste reduction and a change for process efficiency. Given the huge number of small business firms in the Nation, this lack of distinction and the promotion of government loans for waste reduction could initiate an ultimately costly, unbounded industrial loan program. (See the discussion of this problem under Policy Option III in ch. 2 of this report.)

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[1] Section 404, which authorizes PCFGs, was added to the act by Public Law 94-305 in 1976.

[2] Karen Brown, Small Business Ombudsman, U.S. Environmental Protection Agency, personal communication, May 29, 1986. See the Ombudsman's office report, "Evaluating the Need for an SBA Pollution Control Financing Program," May 16, 1986.

[3] 13 CFR Part 111.

[4] Small Business Ombudsman, U.S. Environmental Protection Agency, "Assistance Programs for Pollution Control Financing," March 1986. A possible complication may arise over a statement that appeared about PCFGs in the *Federal Register* on June 4, 1986 (vol. 51, p. 20247): "PCFG assistance . . . is intended for small concerns to comply with ecological standards by installing *non-productive pollution abatement equipment, purchased incident to their other profit-oriented activities.*"

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present time and later, recycling. When research has thoroughly explored these means to manage wastes, then the center may consider waste reduction. The center is increasingly dependent on industry funding. It has not noted any current interest on the part of industry in gaining outside assistance in the development of waste reduction techniques because ". . . such activity is handled internally and always coupled with production cost and improved competitiveness needs."[152]

At the University of Alabama in Birmingham, a Hazardous Materials Management and Resource Recovery Program (HAMMARR) was

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[152] John Liscowitz, Executive Director, Institute for Hazardous and Toxic Waste Management, personal communication, May 27, 1986.

Table 5-6.—State Level Environmental R&D Centers

Organization and location	Funding source(s)		Annual budget[a]	Waste management v. waste reduction (WR) activities
Center for Environmental Management at Tufts University	EPA	100%	$2.0 million	Little waste reduction. Two waste minimization projects completed. A technical waste treatment study planned.
Industry/University Research Center for Hazardous and Toxic Waste at New Jersey Institute of Technology	NSF	3%	$3.0 million	Concentrates on waste treatment methods; no WR research planned.
	State of New Jersey	66%		
	Private sector	16%		
Hazardous Materials Management Resource Recovery Program at University of Alabama	State of Alabama	66%	$0.2 million	Aim to eventually focus on WR, but initial projects are on recycling, treatment, and regulatory compliance.
	University	33%		
Illinois Hazardous Waste Research and Information Center	State of Illinois	100%	$1.3 million	"Prevention and Source Reduction" is one of 4 research areas. WR is now 10 percent of technical assistance work. No WR research yet.

[a] Estimated operating and research.

SOURCE: Office of Technology Assessment, 1986.

established in late 1985. The prime goal of the facility is to support research "aimed at ultimately eliminating by-product wastes from manufacturing processes."[153] So far, funding support for this waste reduction research has proven difficult to acquire from either government agencies or the private sector. Initial projects—funded primarily by the Alabama Development Office—have included establishment of a regulation information newsletter, development of a waste exchange information service and a training assistance program for RCRA generators, and waste incineration research. The organization hopes to have one or two waste reduction engineering research projects funded within a year.[154]

The Center for Environmental Management at Tufts University is funded principally by EPA at a cost of $2 million per year. The center's mission is "to develop an effective approach to environmental management through innovative research, policy analysis, education, and information exchange programs."[155] Waste Reduction and Treatment is one of four "clusters of concentration." Two projects have been completed: a study of foreign government waste minimization practices and the organization of a conference. A technical project on onsite treatment is being planned.

Illinois' Governor and Legislature created a Hazardous Waste Research and Information Center in 1984. One of five objectives of the center is: "Reducing the volume of hazardous wastes generated and the threat they pose to human health and the environment."[156] Prevention and Source Reduction Studies is one of four research areas, and projects in this area that "will support industries' efforts to minimize or prevent hazardous wastes from being produced or to detoxify those wastes"[157] (i.e., waste reduction *and* waste treatment). Actual work in waste reduction has, so far, only been incorporated into the activities of the center's technical assistance project (see ch. 6).[158]

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[153] University of Alabama, "Hazardous Materials Research Center Will Aid Industry," *Capstone Engineering*, vol. 2, No. 1, Winter 1986.

[154] George Whittle, Coordinator, Hazardous Materials Management and Resource Recovery Program, University of Alabama, personal communication, July 10, 1986.

[155] The Center for Environmental Management, Tufts University, promotional brochure, undated.

[156] Hazardous Waste Research and Information Center, *Annual Report (May 1, 1985 - April 30, 1986)*, p. iv.

[157] Ibid., p. viii.

[158] David L. Thomas, Director, Hazardous Waste Research and Information Center, personal communication, May 1986.

Other Federal Agencies: R&D and Information Transfer

There are a variety of ways in which existing Federal agencies could promote waste reduction. The Department of Defense and a major Department of Energy facility have newly initiated internal waste minimization programs to help ameliorate their own hazardous waste problems. This work may have limited value outside of the agencies in terms of technology transfer. More important to this discussion on waste reduction may be the incentives each agency has instituted to reduce the generation of hazardous wastes. The Tennessee Valley Authority has been instrumental in assisting States in its region to promote waste minimization. The Occupational Safety and Health Administration indirectly promotes waste reduction through its regulation of hazardous materials in the workplace.

As discussed in chapter 3 of this report, waste reduction technology is a misleading phrase. It implies that there are distinct technologies that lead to the reduction of waste. But waste reduction is, instead, a criterion by which to assess almost any industrial production technology. By the same token, R&D in waste reduction encompasses many aspects of industrial production. Thus any Federal agency already offering support to U.S. industry could also assist its waste reduction efforts.

The Department of Defense

DOD generates over 500,000 tons of RCRA hazardous waste annually[159] and has identified several hundreds of sites that will require cleanup at an estimated cost of $10 billion.[160] Logistics operations (procurement, maintenance, and transportation of materiel and facilities) are the major sources of new waste. The need to minimize the generation of this waste has been recognized in the Office of the Secretary of Defense (OSD) and in each of the military services.

A DOD policy on hazardous waste was established in 1980 which cited as the first step a determination to "limit the generation of hazardous waste through alternative procurement practices and operational procedures."[161] Waste minimization within the Navy, Army, and Air Force has preceded—and been the impetus for —the development of an official DOD waste minimization plan. These individual efforts are outlined in table 5-7. Throughout DOD, waste minimization has been defined broadly to include reduction, recycling, reuse, and treatment. Waste reduction, therefore, constitutes an unknown part of DOD waste minimization activities, most of which are focused on RCRA hazardous wastes.

The Joint Logistics Commanders' Hazardous Waste Minimization Ad Hoc Working Group (JLC Working Group)[162] submitted a report to OSD in December 1985 which recommended the elements for a DOD waste minimization program (see details below). As of mid-1986, OSD was formulating a directive that would require all parts of DOD to develop waste minimization plans. Funding of $30 million for fiscal year 1987 has been requested. For fiscal year 1986, $47 million had been approved for the existing individual programs but was eliminated because of overall Federal Government Gramm-Rudman-Hollings budget constraints. Services were, however, subsequently authorized to spend approximately $5 million for waste minimization out of a $50 million supplemental appropriation for DOD's cleanup program.

A number of procedures within DOD that have counterparts in the private sector have been identified as key elements in causing excessive hazardous waste generation. A major disincentive to waste reduction within DOD is

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[159] U.S. Congress, General Accounting Office, *HAZARDOUS WASTE: DOD Efforts to Improve Management of Generation, Storage and Disposal*, GAO/NSIAD-86-60 (Gaithersburg, MD: May 1986), p. 10.

[160] U.S. Congress, General Accounting Office, *HAZARDOUS WASTE: Federal Civil Agencies Slow to Comply with Regulatory Requirements*, GAO/RCED-86-76 (Gaithersburg, MD: May 1986), p. 9.

[161] U.S. Department of Defense, DEQPPM 80-8, Oct. 21, 1980.

[162] Members include representatives from the Defense Logistics Agency, Naval Materiel Command, the Army Materiel Command, the Air Force Logistics Command, and the Air Force Systems Command. Groups such as the Strategic Air Command and the Tactical Air Command are not represented.

Table 5-7.—Waste Minimization (WM) at the Department of Defense

Office of the Secretary:

Defense Environmental Leadership Project (see text).

Defense Logistics Agency (DLA) provides material support (procurement, quality control, storage, distribution, maintenance). Has instituted some informal changes in materiel ordering to reduce wastes created by shelf-life regulations.

Navy:

All Commands required to report by April 1986 on WM measures taken. Object is to raise awareness of issue and accumulate information for transfer across Commands.

Naval Civil Engineering Lab is investigating private industry initiatives for transferability to Naval operations.

Army:

Army Materiel Command (AMC) has developed a Hazardous Waste Minimization (Hazmin) Plan. All AMC installations must implement wide range of activities including reduction goals (15 to 60 percent by 1992) for major wastes streams (metal working, electroplating, painting, electrical maintenance, and waste treatment sludges). Also disposal of untreated wastes in landfills to be eliminated by 1992.

Air Force:

Office of Secretary of Air Force has several studies underway on decisionmaking and costing practices that affect waste generation.

Air Force Systems Command (AFSC) requested $13 million from Defense Environmental Restoration Account for WM in 1986. Has completed assessment of WM opportunities in 8 major facilities (U.S. Air Force, Aeronautical Systems Division, *Waste Minimization at Air Force Plants*, by the Earth Technology Corporation, 1986)

Air Force Logistics Command (AFLC) "Pacer Reduce" WM plan in place since end 1985. Set overall goal of over 50 percent reduction by 1992. Has taken complete waste stream inventory by process. Studying technologies in private sector for transfer to AF operations. Some R&D conducted at Tindle AFB.

SOURCE: Office of Technology Assessment, 1986.

that the Defense Property Disposal Office removes hazardous waste from facilities without charge. Thus, DOD's production and storage facilities need not consider the cost of hazardous waste management in their operations. In addition, because DOD tends to order materials in excess of needs, many materials outlive their shelf-life and end up as hazardous waste. According to a 1986 DOD report, because of the many components of DOD, even within military departments, and because there has been a lack of official oversight, it is difficult to disseminate waste reduction processes and innovative ideas throughout the agency.

DOD is not necessarily a source of technology transfer to the private sector. R&D in DOD often occurs in areas where the applicability is unique to DOD or where DOD constitutes a large part of the industry (e.g., aircraft manufacturing). The agency considers that the private sector—because of its costs incentives—is more likely to generate more and better waste reduction techniques.[163] Most DOD waste minimization programs include scouting the private sector for technology.

DOD Goals.—DOD may establish a policy that is transferable to the private sector and other government agencies—the setting of nonbinding reduction goals which are to be incorporated with increased stringency. Such goals, to be met by 1992, have already been established within some military departments, based on waste streams or processes. For instance, the Army has reduction goals in place that are to be met by 1992. They include reductions of 60 percent for electrical maintenance and waste treatment sludges, 50 percent for electroplating and painting wastes, and 15 percent for metal working wastes. In the Air Force an overall goal of 50 percent reduction by 1992 has been set. DOD already has established a goal to eliminate the disposal of untreated hazardous waste by 1992 through waste reduction, recycling, and treatment.

JLC Working Group.—The JLC Working Group was created in September 1985 because of concern about "the serious liabilities associated with the generation and subsequent handling and disposal of hazardous wastes."[164] The Group's Hazardous Waste Minimization Program, which was submitted to OSD in December 1985, includes a number of elements for each DOD department to implement. They include: accurate annual waste reporting, material control programs, reviews of existing technology and activities, coordination between services, implementation of "economically practicable hazardous waste minimization technology" and the initiation of R&D, consideration of waste minimization in all acquisition programs, and the development of reduction goals and monitoring of progress within each command. The group identified hazardous material control, delisting, material substitution, process change, and recycling as "means of hazardous waste minimization."[165]

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[163] Captain Jay Green, United States Navy, Chairman, Joint Logistics Commanders' Hazardous Waste Minimization Ad Hoc Working Group, personal communication, Apr. 3, 1986.

The program requires that R&D be coordinated among departments to avoid duplication. Necessary spending levels were estimated at $10 million per year for each of the military departments, with funds for development of these programs to be taken from the Defense Environmental Restoration Account.[166]

Office of the Secretary of Defense.—Currently, two different groups within OSD have worked on waste minimization: The Defense Logistics Agency (see table 5-7) and the Defense Environmental Leadership Project (DELP).

DELP was founded in January 1984 by the Director of Environmental Policy at the Pentagon. It was originally funded for a 2-year trial period but has since been extended indefinitely. DELP's stated mission is to find innovative solutions to long-term environmental problems that have cost and policy implications and to improve DOD's national leadership position in environmental protection. The program has focused its activities on improving DOD compliance with environmental regulations and minimizing waste.

DELP is searching out and publicizing waste reduction success stories within DOD to encourage development and implementation of industrial process modifications that will reduce the amount of hazardous waste generated at DOD facilities.[167] The first phase of this project evaluated 40 case studies of industrial process modifications and recommended 18 of these for further study in phase two of the project. From these 18 case studies, three were selected as "Projects of Excellence." The third phase includes training sessions at a number of DOD installations on applying the techniques developed in the three selected projects.[168] The final three projects were: a paint-stripping process using plastic pellet blasting, modifications to metal plating, and reducing solvent and oil pollution from vehicle washing and maintenance. The 2-year project cost approximately $300,000, primarily for contractor support. It has been completed and no other major waste reduction efforts are pending in DELP.

Department of Energy

DOE faces estimated costs of $750 million for environmental cleanup at three of its facilities. Among Federal agencies, this cost is second only to DOD's.[169] Eighty-six percent will be spent at the Oak Ridge, Tennessee, facility. DOE has not yet began a formal waste minimization program but has had an informal program at its Oak Ridge National Laboratory since mid-1985.[170]

Two important changes have been made to create incentives for both DOE contractors and individual researchers to consider waste reduction. First, the reduction of hazardous wastes has been added as a fee criterion to contracts. Thus, those contractors who can show a reduction in wastes can qualify for increased payments. Secondly, DOE's Waste Management Division no longer assumes the costs for the management of wastes generated at Oak Ridge. Instead, such costs revert back to each generator.

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[164] Joint Logistics Commanders, Hazardous Waste Minimization Program, memorandum to William H. Taft, IV, Deputy Secretary of Defense, Dec. 12, 1985.

[165] Ibid.

[166] Captain Jay Green, op. cit.

[167] Such facilities include many that are often confused with the private sector. Manufacturing plants are often government-owned, contractor-operated (GOCO) facilities. Repair and reconditioning facilities, on the other hand, are typically government-owned and government-operated (GOGO).

[168] DOD Environmental Leadership Project, *Industrial Processes To Reduce Generation of Hazardous Waste at DOD Facilities*, Phase 2 Report: Evaluation of 18 Case Studies, prepared by CH2MHill (T.E. Higgins), July 1985, p. 2.

[169] U.S. Congress, General Accounting Office, *HAZARDOUS WASTE: Federal Civil Agencies Slow to Comply with Regulatory Requirements*, op. cit.

[170] Bob Sleeman, Waste Management Division, Oak Ridge, Department of Energy, personal communication, June 30, 1986.

DOE is unique in that its facilities generate radioactive wastes that must be handled quite differently from RCRA hazardous wastes and from water and air pollutants that are also produced. Radioactive wastes cannot be destroyed; they must be stored, usually after being encapsulated. The waste minimization program at Oak Ridge began because the facility was facing storage constraints for radioactive wastes that were contaminated with liquid RCRA hazardous wastes. The success of efforts to prevent the contamination of radioactive wastes and thus significantly reduce the volume of radioactive wastes needing storage led the Waste Management Division to apply waste minimization to its RCRA waste problems. A secondary reason for this action was the subsequent waste minimization requirements imposed by the 1984 RCRA Amendments.

The facility's waste minimization efforts are now being geared primarily toward reducing RCRA hazardous waste generation at the source. During the investigation of processes that generate RCRA hazardous wastes, however, possibilities for air and water pollution reductions have been discovered. One project, for instance, resulted in the substitution of a water-based for a solvent-based coolant. The solvent coolant had to be managed as a RCRA hazardous waste and was the source of air emissions as well. Waste reduction efforts are still a minor but increasing component of the Waste Management Division's activities. There is no separate budget item for waste minimization.

Tennessee Valley Authority

TVA is a regional development agency that seeks to attract and keep industries in the valley while at the same time protecting and conserving the resources of the valley. Helping local industries comply with hazardous waste regulations and manage their wastes in an environmentally responsible way is one way of meeting these goals.

TVA has therefore developed a Waste Management Program that offers technical assistance and information to waste generators and the public on ways to manage and minimize their hazardous wastes. The annual budget for this program totals $2 million.[171] TVA defines waste minimization to include many facets of waste management as well as waste reduction. To date, its activities have been strongly focused on promoting recycling and reuse and good management practices—and there have been some encouraging results.[172] While there is some recognition of its value at TVA, little waste reduction work has yet been done so far.

States in the TVA region have received support from TVA for their activities in promoting *pollution prevention pays* through State conferences. Such conferences bring the concept of waste reduction and proper waste management to State generators and disposal operators, government officials, and educators. They do not concentrate on waste reduction or present waste reduction as the preferred choice. They do tend to provide the initial consensus gathering which can serve as the base for an official State program. TVA participates in these conferences and functions as a cosponsor. An estimated $35,000 of its Waste Management Program budget is used for this purpose. So far, conferences have been held in Alabama (October 1985) and Tennessee (March 1986). A third conference is scheduled for Kentucky in late 1986.

Occupational Safety and Health Administration

OSHA, in the Department of Labor, regulates hazardous materials in the workplace and through some of these actions has influenced industrial management of hazardous materials. The Hazardous Communication Standard, which went into effect in November 1985, requires that manufacturers and distributors of chemicals provide their customers and workers with Materials Safety and Data Sheets (MSDS) and that they label hazardous products. Users of chemicals, such as the auto and steel industries, have until May 1986 to develop such data for the chemicals they mix for their own operations. Intensive safety training programs for workers must also be in place at that time for both chemical and nonchemical industry employers. Currently these measures apply only to manufacturing industries, however OSHA has proposed broadening application of the standard to cover service industries as well.

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[171] Dr. Philip J. Mummert, Projects Manager, Waste Management Program, Tennessee Valley Authority, personal communication, July 23, 1986.

[172] Doye Cox, Program Manager, Solid and Hazardous Waste Management, Tennessee Valley Authority, personal communication, Mar. 28, 1986.

In addition to alerting employers and workers to workplace hazards, these worker right-to-know measures, by publicizing the hazardous constituents of materials, have served as catalysts for waste reduction.[173] Substitution of nonhazardous materials into processes may result from worker pressure or from the fact that implementing worker safety measures could be more expensive than substituting nonhazardous materials. Improved segregation and recycling (as well as improved management) may result as businesses learn more about hazardous constituents in manufacturing inputs. The information provided by MSDS may be particularly useful to smaller businesses, which may not have the facilities to test all their raw materials for hazardous constituents and which, therefore, may not have known what was in their waste streams. The regulations governing MSDS, however, allow for certain proprietary exemptions which can mask the contents of a product.

All of these possible effects on waste reduction are indirect. Waste reduction—in the form of materials substitution—has been part of OSHA's traditional method of protecting workers. Its regulations require that engineering and work practice controls be used to comply with standards unless they are not feasible—in which case, personal protective equipment may be used. Health and safety professionals use a hierarchy of engineering controls: substitution, enclosure, isolation, and ventilation.[174] How prevalent substitution is as a method of regulatory compliance is not known. One OSHA publication about protecting workers from exposures to methylene chloride suggested that: "The best method for controlling exposure to any extremely toxic material is to use a less toxic material where possible."[175] The bulk of the document, however, presented end-of-pipe solutions to industry-specific problems.

OSHA has done little research and taken no specific action to push reduction. In fact, OSHA's powers to advocate waste reduction are very limited. OSHA itself has no jurisdiction over hazardous *wastes*, which are regulated under EPA statutes. In addition, while it can require publication of known health risk data about hazardous chemicals, the Agency cannot require the generation of any new health studies or data; that power is given to EPA under TSCA.[176]

Potential Sources of Waste Reduction R&D

There are a number of agencies within the Federal Government that conduct industrial R&D and that, therefore, could be sources of waste reduction technical assistance and information transfer. Two prominent examples are the Bureau of Mines and the National Bureau of Standards. In addition, the National Science Foundation, which has traditionally been a funding source for basic research in universities, has now established Engineering Research Centers that could conduct industrial applied research relevant to waste reduction.

The National Bureau of Standards in the Department of Commerce provides a variety of scientific and technological services to industry and government. Three of its four divisions —the National Engineering Laboratory, the Center for Chemical Engineering, and the Center for Materials Science—conduct basic and applied research that can lead to improved processing of chemicals and materials. Waste reduction is a form of improved processing.

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[173] *Business Week* reported that "several newspapers now are ordering different—albeit more expensive—inks that do not carry the jarring label." The magazine was referring to notification of newspaper publishers by ink manufacturers that "one widely used printer's ink would have to be labeled a possible carcinogen . . . " [Dec. 9, 1985, p. 86H].

[174] U.S. Congress, Office of Technology Assessment, *Preventing Injury and Illness in the Workplace*, OTA-H-256 (Washington, DC: U.S. Government Printing Office, April 1985), p. 175.

[175] Occupational Safety and Health Administration, Office of Science and Technology Assessment, "Guideline for Controlling Exposure to Methylene Chloride," OSHA Instruction PUB 8-1.2, Mar. 10, 1986.

[176] Jennifer Silk, OSHA, personal communication, Apr. 15, 1986.

The Bureau of Mines is the Federal agency that those in the mining and mineral processing industries look to for technical assistance and process information. One of its goals is to "ameliorate conflicts between environmental goals and mining operations and mineral processing and utilization plants."[177] The Bureau has an ongoing program in reuse and recycling R&D, and $25.3 million have been requested for R&D in extractive metallurgy and recycling technologies for fiscal year 1987. Waste reduction has not yet been added to its research efforts.

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[177] U.S. Congress, House of Representatives, Hearings before a Subcommittee of the Committee on Appropriations, *Department of the Interior and Related Agencies Appropriations for 1987*, Part 2 (Washington, DC: U.S. Government Printing Office, 1986), p. 5.

Chapter 6

State Activities in Waste Reduction

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Chapter 6

State Activities in Waste Reduction

INTRODUCTION

State governments have taken the initial steps in establishing programs related to waste reduction. The first program was formed in 1981 in New York; programs in North Carolina and Minnesota followed in 1983 and 1984. With few exceptions, the prime rationale for the existing programs and those being planned is to help ameliorate the contentious local issue of siting new hazardous waste facilities.[1]

In preparing this report, OTA studied *existing* State waste reduction activities. Environmental programs have most often been designed at and mandated from the Federal level; but in the case of waste reduction, States have assumed a leadership role. Healthy, effective, and growing State-level efforts in the absence of a Federal program would suggest that Federal action is not critical to the advancement of waste reduction. Instead, **OTA found a patchwork of programs that are often more concerned with waste management than with waste reduction and that indicate a need for parallel Federal leadership.**

Promoters of the concept *pollution prevention pays* point to the State lead, which grew from interest at the local level, as indicative of a groundswell of public support for waste reduction. But many questions must be asked. How widespread are these programs across the Nation? What are individual programs actually trying to accomplish? How effective are they in promoting waste reduction initiatives in local industry? To what extent are their efforts concentrated instead on waste management?

This chapter begins with a discussion of the extent of State-level efforts and presents two minimum criteria for defining State waste reduction programs. Next, the chapter analyzes the direction, content, and focus of existing State efforts and the effectiveness of these efforts in increasing the implementation of waste reduction in industry. The chapter concludes with an analysis of changes needed at the State level and in the State/Federal relationship to improve the chances of adding pollution prevention as a complement to the traditional pollution control approach to environmental protection.

This chapter *does not* attempt to analyze the level of success each individual State program has achieved in carrying out *the State mission for which it was created*, since often that mission is broader than the encouragement of waste reduction. Thus, a finding about waste reduction may have no bearing on the viability of a program from the State perspective.

The existing State programs have been designed and are being run by people who are very committed to their programs. They tend to be extremely knowledgeable about the State's industry and its hazardous waste problems. Given political realities, the programs have started out small with the goal of gaining a permanent presence in the State's environmental protection structure. As first generation programs, they tend to be inventive and they often focus on new approaches to environmental protection. At the same time a cautiousness exists about alienating those who see waste reduction as a threat or as competition for State resources and attention.

Collectively, these programs are not promoting waste reduction in any major way. They are too few in number, do not focus on waste reduction, and concentrate on small business. While the number of State programs appears to be growing, individual budgets are not growing, and the future of these programs as a substantial force for waste reduction nationwide is in doubt. This does not mean, however, that existing State programs should be discounted when designing and adopting Federal policies; current and future State programs could become the vehicles for implementation of Federal policies.

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[1] At the State level, the siting issue appears to provide the major impetus for waste reduction, just as waste management costs provide incentive in the private sector.

EXISTING PROGRAMS AND PLANNING EFFORTS

OTA found a growing number of variously constituted programs underway at the State level that promote waste reduction with differing degrees of effort. States other than New York, Minnesota, and North Carolina are becoming active; still others are engaged in planning. Local governments are also becoming involved (see box 6-A).

Difficulties in surveying these efforts arise from the fact that there are no existing, agreed upon definitions that answer the basic questions: *What is waste reduction? What constitutes a State waste reduction program?* OTA chose initially to leave program definitions up to individual States, simply asking States in its survey conducted in January 1986, if they had a waste reduction program. Of the 51 replies received, 12 were affirmative. Ten States that answered in the negative indicated that they were planning programs. Twenty-nine States responded that they did not have a program and were not designing one. Table 6-1 contains a modified version of OTA's State survey.[2,3]

Because there are no operating State programs based solely on reducing waste at the source of generation, a basic definition made up of two criteria was then used by OTA as a starting point for analysis of State *waste reduction* programs. **One criterion was the existence of an organizational focal point for waste**

Box 6-A.—Local Governments and Waste Reduction

Some local (city and county) governments and groups across the country are actively pursuing ways to promote waste reduction efforts in local industries. The existence of local-level activity should be kept in mind as Federal policies are considered and adopted. It was not possible for OTA to include a thorough review of waste reduction at the local level in this report; two examples are highlighted below.

In California's Santa Cruz County, a local ordinance (No. 3725) was passed in 1986 that can require facilities that handle or store hazardous materials to submit a Hazardous Materials Management Plan as part of a permitting procedure. In the plan the facility must document the use of best available control technologies or waste reduction in the handling of hazardous materials. Fees are charged such facilities based on the amounts of hazardous materials handled and stored onsite.

Under pressure from its citizens, the city council of Saco, Maine, passed an ordinance in 1986 requiring a local firm to finance an independent review of waste reduction and treatment options for dealing with wastewater contaminated with heavy metals. When the review is completed, the council will decide whether to impose waste reduction measures as a condition for a local permit to discharge the wastewater into surface waters. (This citizen project is described in "A Community-Based Source Reduction Campaign To Protect the Saco River," by the Maine Peoples Alliance and the National Campaign Against Toxic Hazards.)

For the most part, local governments use their authority over land use to become involved in environmental issues such as waste reduction. For details, see Susan Sherry, et al., Golden Empire Health Planning Center, *High Tech and Toxics: A Guide for Local Communities* (Washington DC: Conference on Alternative State and Local Policies, 1985).

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[2] In December 1985, OTA prepared a survey to gather information for this report and document activity at the State level. All 50 States and the District of Columbia were sent a 10-page questionnaire with 35 questions. OTA was aware that the term *waste reduction* has many definitions and, therefore, asked each State to provide its own definition and to respond to the questionnaire within that context. Eventually, responses were obtained from the entire survey group. It became obvious when the answers were tabulated that some of the questions were ambiguous and produced unclear responses. Those problem questions plus others which proved irrelevant have been eliminated from the results in the modified version as shown in table 6-1. Whenever possible, responses have been clarified by telephone.

[3] The table shows that States with names that start with the letters N through Z have a lower probability of having a waste reduction program than those at the upper end of the alphabet.

Table 6-1.—Results of OTA State Survey

	States																									
	AL	AK	AZ	AR	CA	CO	CT	DE	DC	FL	GA	HI	ID	IL	IN	IA	KS	KY	LA	ME	MD	MA	MI	MN	MS	MO
Does State have program?	N	N	n	N	Y	n	Y	n	n	N	n	N	N	y	N	N	Y[a]	n	n	N	n	Y	Y	Y	N	y[a]
If yes, when established?	—	—	—	—	84	—	85	—	—	—	—	—	—	84	—	—	81	—	—	—	—	85	85	84	—	
Why established?	—	—	—	—		—		—	—	—	—	—	—		—	—		—	—	—	—				—	
Land disposal shortfall														X										X		
Treatment shortfall																						X		X		
Public support for program							X															X		X		
Lack of insurance for WM																										
Escalating WM costs					X		X																	X		
To improve WM					X		X							x			X					X	X	X		
Need to minimize HW sites					X																	X	X			
RCRA 1984 Amendments							X							x								X				
Other comments																										
If no program, why not?					—		—							—			—					—	—	—		—
Lack of funds	X	X				x						X	X		X	X				X					X	
Need for facilities more urgent													X		X	X										
Waste generation not priority item				X				x	x						X											
Waste reduction not priority issue										x											x					
RCRA reg program takes resources																										
Other comments	b												c							d						
Is there planning effort in State?	Y	N	n	N	Y	n	Y	n	n	Y	n	N	N	y	N	N	N	y	n	N	n	Y	Y	Y	N	n
Is program/planning focused on RCRA hazardous wastes (R) or multimedia pollutants (M)?	R	—		—		—	R	—	—	r	—	—	—	m	—	—	—	m	—	—	—	M	R	r	—	
Has State considered facilitating or requiring WR plans by industry?	NR	—	n	—	Y	—	N	n	n	Y	n	N	N	n	Y	N	N	n	y	N	—	Y	N	N	N	—
Does State have a technical assistance program (TAP)?	N	—	n	—	Y	—	Y	n	n	P	y	N	N	y	N	N	N	n	n	N	—	P	P	Y	N	—
Does State TAP provide onsite assistance?	—	—	—	—	Y	—	N	—	—	—	y	—	—	y	—	—	—	—	—	—	—	—	—	Y	—	—
Has State held or planning to hold waste reduction conferences?	Y	Y	n	N	Y	—	Y	n	n	Y	n	N	N	y	N	N	Y	y	y	N	—	Y	N	Y	N	—
Has State developed information material on waste reduction for its industry?	Y	N	n	N	Y	—	Y	n	n	P	n	N	N	y	N	N	Y	y	n	N	—	Y	P	Y	N	—
Does State impose taxes and/or fees on chemical production or wastes?	Y	N	n	Y	Y	nr	Y	y	n	Y	n	N	Y	y	Y	Y	Y	y	y	Y	nr	Y	P	Y	N	y
Are economic incentives used in your State that could promote waste reduction?	NR	NR	n	—	Y	—	Y		n	Y	n	NR	N	y	Y	N	N	n	y	NR	—	P	P	Y	Y	n

Table 6-1.—Results of OTA State Survey—Continued

	States																								
	MT	NE	NV	NH	NJ	NM	NY	NC	ND	OH	OK	OR	PA	RI	SC	SD	TN	TX	UT	VT	VA	WA	WV	WI	WY
Does State have program?	Y[e]	n	N	n	N	N	Y	Y	N	N	N	n	N	n	N	n	N	N	N	N	n	N	n	Y	N
If yes, when established?	82	—	—	—	—	—	81	83	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	84	—
Why established		—	—	—	—	—			—	—	—	—		—	—	—	—	—	—	—	—	—	—		—
Land disposal shortfall							X																	X	
Treatment shortfall																									
Public support for program	X						X	X					P				P							X	
Lack of insurance for WM																									
Escalating WMgmt costs	X						X						P											X	
To improve WM							X	X					P				P							X	
Need to minimize HW sites							X																	X	
RCRA 1984 Amendments																	P								
Other comments								[f]																	
If no program, why not?	—						—	—																—	
Lack of funds		x		x		X			X		X	x	X		X	x	X	X	X	X					X
Need for facilities more urgent			X		X						X				X										X
Waste generation not priority item									X			X				x	X			X					X
Waste reduction not priority issue		x																							
RCRA reg program takes resources													X												
Other comments				[f]		[g]						[h]		[i]		[j]				[k]				[l]	
Is there planning effort in State?	N	n	Y	n	Y	N	Y	Y	N	N	N	n	Y	n	Y	n	Y	Y	N	N	n	Y	n	P	N
Is program/planning focused on RCRA hazardous wastes (R) or multimedia pollutants (M)?	R	—	R	—	R	—	M	M	—	—	—	—	R	—	NR	—	R	NR	—	—	—	M	—	R	—
Has State considered facilitating or requiring WR plans by industry?	N	—	—	—	NR	N	N	Y	N	Y	N	n	N	—	N	—	N	N	NR	N	—	N	—	Y	N
Does State have a technical assistance program (TAP)?	N	—	N	—	P	N	Y	Y	N	Y	N	n	P	—	N	—	Y	N	N	N	n	Y	—	Y	N
Does State TAP provide onsite assistance?	—	—	—	—	P	—	Y	Y	—	Y	—	—	N	—	—	—	Y	—	—	—	—	N	—	Y	—
Has State held or planning to hold waste reduction conferences?	Y	—	N	—	Y	N	Y	Y	N	Y	N	n	Y	—	N	—	Y	N	N	N	n	N	—	Y	N
Has State developed information material on waste reduction for its industry?	N	—	N	—	Y	N	N	Y	N	N	N	n	N	—	N	—	Y	Y	N	N	n	N	—	N	N
Does State impose taxes and/or fees on chemical production or wastes?	Y	n	N	y	Y	N	Y	Y	N	Y	P	y	N	y	Y	n	Y	Y	N	Y	n	Y	y	Y	N
Are economic incentives used in your State that could promote waste reduction?	NR	n	NR	n	NR	—	Y	Y	NR	Y	NR	y	P	n	NR	n	N	NR	NR	NR	n	P	n	Y	—

KEY: QNR = questionnaire not returned.
NR = no reponse to question.
N = no.
Y = yes.
P = pending or planning.
— = not applicable.
NOTE: Use of lower case letters indicates that OTA obtained information by telephone.

[a] Only waste exchange.

[b] No statutory authority; WR not identified as issue.

[c] No HW program in State.

[d] No attention given WR.

[e] Informal WR assistance with regulatory permitting process.

[f] WR already occurring due to high transportation costs.

[g] Not included in EPA work grant.

[h] No political pressure for WR.

[i] WR not needed.

[j] No authority to require.

[k] Would have if EPA funds available.

[l] Industry argues WR not necessary; awaiting Federal guidance and leadership.

reduction activity in the State government. The other was a current offering of some waste reduction services to industries in the State. These criteria eliminated those States that have only a legislated or executive policy statement on waste management practices, those in which efforts are directed at studying possible types of services to offer, and those in which service is limited to, for instance, a waste exchange or a Governor's award. Using these criteria, OTA found that there were waste reduction programs in 10 States: California, Connecticut, Georgia, Illinois, Minnesota, North Carolina, New York, Pennsylvania, Tennessee, and Wisconsin. As table 6-2 shows, each has a different mix of components, level of budget, and extent of concentration on waste reduction.

State planning efforts (see table 6-3) indicate that the number of programs may increase. In fact, some States such as Massachusetts may satisfy the above criteria by the time this report is in print. These planning efforts, however, are at different stages and there is no uniformity from one State to another about what constitutes a planning effort. Some programs have been officially initiated (i.e., have a legislative or executive mandate to operate) but are still planning their structure and implementation. Some planning efforts are aimed at developing the consensus necessary to obtain the legislative or executive mandate to operate. Some programs already underway are still planning how best to broaden their activities. When and if all the planning efforts now underway culminate in waste reduction programs, about a third of the States will be promoting waste reduction to some extent.

The lack of a standard definition for the term waste reduction is another source of difficulty in surveying State efforts. One of the major findings of this report is that the definition of waste reduction guides and focuses the activities of any program; the inclusion of waste management in a definition tends to shift efforts away from waste reduction. OTA found that State definitions often include offsite recycling and waste treatment. As an example of the variety that exists, table 6-4 gives the 13 definitions reported on OTA's State survey.

With few exceptions, all of the State programs can be considered waste minimization programs; their primary concern is to encourage any activities that may reduce the use of land disposal facilities.[4] They do not focus on reducing the generation of waste at the source.

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[4] Throughout this report, waste minimization is considered to include activities that reduce the amount and/or toxicity of wastes either before *or after* they are generated. This is consistent with EPA's working definition of the term as used prior to the release of its report to Congress.

SOME GENERALIZATIONS ABOUT STATE PROGRAMS

Despite a lack of consistency and their potential for change, it is possible to make some generalizations about State programs:[5]

- they are new;
- the force driving their initiation and sustaining their momentum is public distrust of land disposal for hazardous wastes;
- good waste management practices are stressed rather than waste reduction, and siting new waste management facilities is a major goal;
- RCRA hazardous wastes are the target pollutants;
- their target industries are small and medium-sized businesses, along with small quantity hazardous waste generators;
- budgets are relatively small;
- a nonregulatory framework is preferred;
- technical assistance is the predominant program component; and
- little systematic information or data collection is underway to assess program effectiveness.

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[5] While collective analysis of the 10 waste reduction programs identified by OTA serves as the primary basis for the discussion in this section, experiences in States with planning efforts have also been taken into account.

Table 6-2.—State Waste Reduction (WR) Programs

Program name and/or coordinating body	Program components	Annual budget[a]	WR as percent of activities	Activities which include waste reduction
California: Alternative Technology & Policy Development Section (Department of Health Services)	Waste Reduction Unit	$1.5 million	<25	Funded studies of 1) economic incentives for WR, 2) waste audit of 5 CA industries, 3) strategies for solvent use reduction.
	Grants program			Funded at $1 million/year; first matching grants awarded July 1986.
	Technical assistance			No onsite consultations offered. Assists in regulatory compliance.
Connecticut: Office of Small Business Services (Department of Economic Development)	Technical assistance	$50,000	<10	Advice on RCRA hazardous waste to SQGs; chief initial role to acquaint firms with new regulations. Fiscal 1987 budget cut to $40,000.
	Loans		unknown	Low interest loans available to small and large firms for WR and waste management projects.
Georgia: Hazardous Waste On-Site Consultation Program (Georgia Tech Research Institute)	Technical assistance	$220,000[b]	10-15	As part of RCRA compliance assistance to SQGs, some WR advice offered. EPA source of 90% of past funding; State to supply all funds for fiscal 1987 at $250,000.
Illinois: Hazardous Waste Research & Information Center	Research	$1.3 million	10	WR will be part of hazardous waste basic/applied research and information transfer services.
Illinois TAP	Technical assistance			WR is part of waste management assistance to small/medium sized firms.
Minnesota: Minnesota Waste Management Board	MnTAP	$180,000	25	Technical assistance, telephone and onsite; seminars and outreach. Summer engineering intern program.
	Research grants	$ 55,000	50	Funded industry RCRA hazardous waste projects in 1985; program under review in 1986. Received $100,000 EPA grant for 1987.
	Governor's Award			Annual award since 1985.
New York: Industrial Materials Recycling Act Program (New York State Environmental Facilities Agency)	Technical assistance	$494,000	<25	Solid/hazardous WR and management advice; primarily telephone, some onsite visits. Operates waste exchange information service.
	Industrial Financing Program		0	Revenue bonds of $131 million since 1976 for pollution control projects by industry; Proposed revolving loan fund would include WR.

Table 6-2.—State Waste Reduction (WR) Programs—Continued

Program name and/or coordinating body	Program components	Annual budget[a]	WR as percent of activities	Activities which include waste reduction
North Carolina:				
Pollution Prevention Pays		$190,000	>50	
	Technical assistance			Multimedia WR and recycling advice by telephone and onsite visits; conduct seminars and outreach.
	Challenge grants			Matching grants (29 since 1985 with $5,000 maximum) for WR and recycling projects.
North Carolina Board of Science and Technology	Research & education grants	$400,000[b]	>50	Grants up to $30,000 each for WR and recycling projects; funds include $100,000 from EPA.
Governor's Waste Management Board	Governor's Award			Annual award since 1983.
North Carolina Technical Development Authority	Financial assistance		unknown	Provides funds for new/improved products/services; tax credit also available for solid/hazardous WR projects.
Pennsylvania:				
PennTAP (operated by Penn State University with funds from State's Department of Commerce)	Technical assistance	$150,000[c]	<50	General technical assistance to small business in State; two staff members handle environmental problems.
Department of Environmental Resources	Demonstration grants	$139,000[b] (1986-87)	unknown	WR and waste management projects eligible.
Tennessee:				
Department of Economic and Community Development	Technology assessment	$100,000[b]	>50	Pilot program in 1986; EPA denied request for continuation of funding for 1987.
University of Tennessee Hazardous Waste Extension Service	Technical assistance	$200,000 (1986-87)	unknown	Technical assistance with onsite waste audits; information clearinghouse and workshops planned.
Waste Management Research and Education Institute	Research	$1.7 million	<25	Policy research and engineering R&D. Two contract projects in 1986 include WR. State funding of $700,000/year approved for 1985-90.
Safe Growth Cabinet Council	Governor's Award			First presented in 1986.
Wisconsin:				
Bureau of Solid Waste (Department of Natural Resources)	Information outreach	$175,000[b]	<25	WR included as part of assistance to RCRA generators, primarily small businesses.
	Planning grants	$500,000	<25	WR and recycling grants totaling $242,000 given to local communities in 1986 from Wisconsin Fund. Fund cut from future State budgets.
	WR and recycling demonstration grants	$350,000	0	Industry project proposals totaling $1 million received; no WR projects included. Program will have only $150,000 to grant in 1987.
	Tax exemptions		unknown	Sales tax exemption available on purchase of WR and recycling equipment.

[a] Based on State's 1985-86 fiscal year, unless otherwise noted.
[b] Includes funds from the U.S. Environmental Protection Agency.
[c] Estimate based on staffing level for environmental assistance.

SOURCE: Office of Technology Assessment, 1986.

Table 6-3.—State Planning: Potential Waste Reduction Programs

State	Status/stage of development
Alabama	Legislation pending
California[a]	New activities proposed to supplement existing program
Connecticut[a]	Preparing recommendations for program expansion for submission to legislature in 1987
Florida	Planning as result of mandate to reduce land disposal of solid wastes
Massachusetts	Developing multimedia program within established regulatory agency; legislation pending
Michigan	Decisions pending on proposals by hazardous waste board and Governor
Nevada	Comprehensive hazardous waste management planning underway
New Jersey	Studies underway to define State hazardous waste facility needs
Pennsylvania[a]	More comprehensive program designed; awaiting funding source
Texas	Recent legislation created interagency coordinating council to plan needs
Washington	Study mandated by legislation underway

[a] Also listed as existing programs in table 6-2.

SOURCE: Office of Technology Assessment, 1986.

Program Support

State and local governments have been under increasing pressure from citizens, the environmental community, regulators, and industry regarding the siting of new hazardous waste facilities. **Most current State waste reduction programs have evolved from studies initiated to investigate the needs for new hazardous waste management facilities.**

For instance, public pressure halting a siting process in the mid-1970s, prompted an investigation by the Joint Study Commission of Minnesota's legislature. The commission concluded that a land disposal facility was needed in the State but recommended that an independent board be created to avoid conflicts of interest. Accordingly, the Minnesota Waste Management Board was established in 1980 to develop a State plan for hazardous waste management and to site disposal and treatment facilities. Embodied in the policy statement of the legislation that created the board was the concept of waste reduction and proper waste management. Minnesota's present program is the result of recommendations made by the board in 1984.

As offshoots from the siting issue, State programs tend to have a broad but limited and hesitant political base of support. As discussed in chapter 1, a certain tension exists among proponents of waste reduction, those attempting to site new hazardous waste facilities, industry, traditional pollution control regulators, and environmentalists. The State programs, poised among the concerns of these groups, tend to exist at a metastable position. Environmentalists, for instance, may wish to have the programs strengthened by imposing some level of regulations. Industry, fearful of further regulatory burdens, strives to maintain the status quo with a focus on those aspects of waste minimization that do not penetrate into the specifics of their operations. Many people—including supporters—view the possible outcomes of waste reduction with high uncertainty. Some are seriously concerned that a potential dilution of pollution control efforts could come about with a shift to waste reduction. State waste reduction programs are, as a consequence, viewed as a small part of overall solutions to environmental problems. This balancing act and level of anxiety constricts State programs to a small niche within the existing environmental bureaucracy and limits their political and financial support.

Waste Minimization

Most States have given waste reduction the top position in their stated policies regarding hazardous waste. Despite these declared intentions, most State programs stress good waste management practices rather than waste reduction. This emphasis may be a consequence of the fact that these programs grew out of hazardous waste siting problems that were created because of poor waste management. Furthermore, waste management has been the traditional control technique approach for dealing with pollution problems. The focus of the Resource Conservation and Recovery Act (RCRA), the basis for most State waste reduction programs, is waste management—not prevention. In addition, firms tend to be open about their waste treatment facilities and techniques, whereas waste reduction deals directly with

Table 6-4.—Definitions of Waste Reduction Provided by States

California: We are using a broad definition of waste reduction which equates with reducing the amount of waste going to or requiring land disposal; this includes on and offsite treatment and recycling as well as source control.

Connecticut: Eliminating or reducing the quanitites of waste produced at the source through process changes. The benefits of waste reduction include reduced liability and elimination of waste needing storage, treatment, and disposal; reduced water use and air emissions; and increased worker safety.

Kansas: Implementation of any process changes or use of other technology which results in the reduction of hazardous waste requiring further treatment or disposal.

Massachusetts: Onsite practices which minimize or eliminate the risk posed by hazardous losses from product processes before they are generated; . . . we consider that the program may incorporate the potential to prohibit the use of specific hazardous inputs and perhaps the manufacture or use of hazardous products if deemed necessary under certain circumstances.

Minnesota: A decrease in the total quantity of hazardous waste generated by the generator through abatement, minimization, reuse, or recycling; or decreases in the quantity which could result in a decrease in risk to public health safety and the environment, even though the quantity [sic] is not decreased.

Montana: Waste reduction = any actions taken that avoid discarding a material. Discard = if it not used, reused, reclaimed, or recycled.

New Jersey: New Jersey's Hazardous Waste Facilities Siting Commission through its Source Reduction and Recycling Task Force consider source reduction, recycling, reuse, and recovery to be the elements of waste reduction. . . . [s]ource reduction is any method or technique applied at the site of generation, the use of which reduces the volume of hazardous waste produced without increasing risk to the public or the environment. Examples include improved process/production control and maintenance, process modification, substitution, equipment changes.

New York: New York State has no "official" definition for waste reduction. The working definition for source reduction is anything which decreases the amount of waste destined for disposal. This definition includes recycling and reuse and is, therefore, not limited to process changes.

North Carolina: The PPP Program goal is to find and apply ways to reduce, recycle, and prevent wastes before they become pollutants. The reduction effort addresses water and air quality, toxic materials, and solid and hazardous wastes. Actions include volume and toxicity reduction, recycle/reuse, process modification, elimination through substitution and waste exchanges.

Pennsylvania: Source reduction—reducing the generation of waste at its source through process or raw material changes.

Texas: Waste reduction is the prevention of waste at its source either by redesigning products or by otherwise changing societal patterns of consumption or industrial patterns of waste generation.

Vermont: Production-based reduction in amount of waste generated.

Wisconsin: Waste reduction . . . to reduce the quantity or the weight of wastes generated. These methods may include, but are not limited to, consumer product redesign to increase product longevity, repair or serviceability; changes in the manufacturing process to produce less manufacturing waste; the utilization of less packaging in consumer products; and the conscious effort to change consumer consumption habits which result in the generation of less waste.

SOURCE: Direct quotes from Office of Technology Assessment State Survey.

processes and operations that firms usually consider proprietary. Thus, **it is easier and safer for State waste reduction programs to focus on traditional waste management.**

OTA could not identify any operating State program that is based exclusively on waste reduction or that gives waste reduction overall primacy. Among States involved in planning, only Massachusetts is developing its program around waste reduction. The North Carolina program does consider waste reduction as a first option in its technical assistance efforts but also promotes recycling, both onsite and offsite. Waste treatment in North Carolina is left to both the regulatory programs and independent consultants who are in the business of selling equipment along with advice.[6]

Often a State's words and deeds seem to be at odds (see box 6-B). The 1985 annual report for Minnesota's technical assistance program (MnTAP) begins with a statement that:

> . . . "pollution prevention" by reducing or eliminating the generation of waste is an important advancement over the concept of managing hazardous wastes after they are generated, through "pollution control."[7]

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[6] Roger Schecter, Director, Pollution Prevention Pays Program, North Carolina Department of Natural Resources and Community Development, personal communication, Apr. 29, 1986.

[7] Minnesota Waste Management Board, *A Year of Service, Minnesota Technical Assistance Program, 1985 Annual Report*, January 1986.

Box 6-B.—California: Waste Reduction Lost Enroute From the Legislature

In moving from the statute to implementation in California, waste reduction took on a new meaning. This incident is similar to what has happened in other States where deeds do not match stated goals, at the Federal level in the implementation of the 1984 RCRA Amendments on waste minimization, and in industry where talk of waste reduction often results in waste management activities. It also shows how a definition can determine program focus.

In 1985 the Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act was passed by the California Legislature. The first legislative finding under the act is a restatement of the two-tiered national policy statement of the 1984 RCRA Amendments that calls for waste reduction and proper waste management. California sharpened the language, however, by explicitly identifying recycling, as well as treatment, as components of proper management. In addition, a distinction is maintained throughout the act by referring to "hazardous waste *reduction, recycling*, and *treatment*" as three separate activities.

The major portion of the act deals with funding and establishing a $1 million annual grant program in the State to promote the research, development, and demonstration of "hazardous waste reduction, recycling, and treatment technologies." These technologies are further and distinctively defined as "technologies and techniques which have, as their primary purpose, the reduced generation of hazardous waste, the recycling of hazardous waste, or the conversion of hazardous waste into a less hazardous form."

Several portions of the act apply only to waste reduction. The act requires *all* generators of hazardous waste to submit a biennial report on "the changes in volume and toxicity of waste achieved through waste reduction." (The Federal waste minimization reporting requirement applies to a subset of generators: only those who ship wastes offsite.) The legislature also required the Department of Health Services, which implements RCRA in the State, to report back by June 1, 1986, on the "establishment of a comprehensive program for achieving reductions in hazardous waste generation." The study was to address various program elements "as they relate to hazardous waste reduction."

The report to the legislature, *Reduction of Hazardous Waste in California*, does not retain the statute's reduction, recycling, and treatment concept. Instead, the Department of Health Services has converted *waste reduction* into an umbrella term encompassing "strategies . . . to reduce the volume of hazardous waste going to land disposal." The components of waste reduction are identified as: recycling (both onsite and offsite), treatment, and source reduction. Source reduction is given the legislature's definition of waste reduction: the "elimination or reduction of generation of hazardous wastes." Doubt is cast on its feasibility by the claim that "its implementation beyond a certain point requires major technological changes and can become costly." Having waved aside the reduction of the generation of hazardous wastes, the report proceeds to discuss primarily waste management in the balance of its 14 pages.

The Waste Reduction Unit of the Department of Health Services does not give any primacy to waste reduction as defined by California's legislature.

The next paragraph introduces the report which, it says,

> . . . documents the hazardous waste reduction, improved hazardous waste management and increased regulatory compliance achieved by Minnesota hazardous waste generators with the assistance of MnTAP.

MnTAP makes most of its contacts with hazardous waste generators over the telephone. In the annual report, seven "primary types of [telephone consultation] assistance" are listed. None pertain to hazardous waste reduction, *as defined above by Minnesota*. The first type is "advice on ways to dispose of hazardous waste that has been generated," three deal with other aspects of hazardous waste management, two with referrals to other State agencies, and one with needs for general information on State programs.[8] In MnTAP's student intern program, waste reduction *does* have primacy. Participating companies are chosen only on the basis of waste reduction projects.[9]

The Fourth Annual Report of New York's Industrial Materials Recycling Program provides another example. The introduction to the report cites the law that mandates the program to "help industry *reduce*, reuse, recycle and exchange industrial materials."[10] But waste reduction rarely appears in the balance of the report that describes the program's activities. For instance, the section on technical information and assistance services ranks waste reduction options first on a list of recommended projects.[11] It then highlights six waste management projects. Appendix D in the report has a detailed list of hundreds of technical information and assistance services offered in 1985. Waste management predominates; there are only two explicit mentions of waste reduction. Two more entries might be either waste management or waste reduction.

RCRA v. Multimedia

For the most part State programs concentrate on RCRA hazardous wastes and give little if any attention to the opportunities for reduction of air and water pollution. Because they emphasize land disposal abatement, few State programs have been designed from a multimedia perspective. However some, due to later influences or the views of people involved in the programs, develop a multimedia approach. The initial basis for the North Carolina program was the State's Waste Management Act which established legislative policy guidelines to encourage and promote ". . . the prevention, recycling, detoxification and reduction of hazardous wastes."[12] Administratively, it developed into a multimedia program. The planning effort in Massachusetts is built around a multimedia concept. The New Jersey Hazardous Waste Facilities Siting Commission is coordinating that State's program planning efforts, and although there is currently a RCRA focus, there is sentiment for broadening to a multimedia focus.[13] Because Illinois' technical assistance program operates under the Hazardous Waste Research and Information Center, it focuses on RCRA hazardous waste but does not have a legislative or executive mandate to do so. The staff responds to other media problems when they arise.[14]

Target Firms

Rather than target firms based on the hazardous waste streams they generate and potential problems they create, State program people deal almost exclusively with small and medium-sized businesses. The often stated rationale for having set this priority is that large firms have the resources to pursue waste reduction and effective management practices and do not need help. The inappropriateness of using limited State resources to assist big business is also often cited.

Another reason for targeting small business can be that industry generally views waste reduction as a threat if it is carried to the regulatory stage. By concentrating on small business entities, State programs do not stimulate the concerns of large firms, which may have the political muscle to influence Governors' and State legislators' attitudes about waste reduction programs. The ability of industry to exert influence, however, can be dependent on the prevailing winds in State government. For instance, the staff members in California's waste reduction program share the conventional wisdom that small business has the greater need for its services, but program efforts are not yet concentrated in that direction.[15] Legislators in that State know—due to the heightened awareness in California regarding toxics—that most of their hazardous waste generators are not small business firms, and they want appropriate action from the program in dealing with the problem.

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[8] Ibid.

[9] Cindy McComas, Director, MnTAP, State of Minnesota, personal communication, May 28, 1986.

[10] New York State Environmental Facilities Corp., *Fourth Annual Report, Industrial Materials Recycling Program 1985*, p. 1. Italics for emphasis.

[11] Ibid., p. 8. The term used in the report is source reduction.

[12] North Carolina General Statute 143B, 1981.

[13] Susan B. Boyle, Assistant Director, New Jersey Hazardous Waste Facilities Siting Commission, personal communication, May 1, 1986.

[14] Frederick L. Doll, Industrial Assistance Coordinator, Hazardous Waste Research and Information Center, State of Illinois, personal communication, May 9, 1986.

Small v. Large

The size of a firm—in terms of annual sales or number of employees—is not necessarily indicative of the amount and/or toxicity of wastes being produced. Targeting solely by firm size may not be the valid way to try to cope with a State's hazardous waste problems or an efficient use of a small budget. In certain States small firms may be more prone than large ones to poor waste management practices, i.e, they may create problems out of proportion to their hazardous waste generation rates.

Another factor that must be considered is that since the goal of most State programs is to *educate* industry as to the benefits of waste reduction, large firms may have as great a need for State services as small and medium-sized firms. It may be true that large firms have greater access to financial resources and technical expertise to pursue waste reduction than do small firms, but these assets may not be used for waste reduction for a variety of reasons. One State—Massachusetts—has recognized the need for top-down support for waste reduction and has plans to offer seminars for corporate CEOs.

Small Quantity Generators

In some cases, small quantity generators (SQGs),[16] are the target industries of State programs, either exclusively or in combination with small business. While the services of the Minnesota technical assistance program are advertised as being " . . . FREE to any Minnesota business," the objectives of the program are "to reduce hazardous waste generation and identify alternatives to land disposal by providing small quantity generators with technical assistance."[17]

SQGs are not necessarily small business firms; on a plant basis a large firm can qualify as an SQG. The appropriateness of using limited resources on SQGs can vary State-by-State. In some States, they may generate a substantial percentage of RCRA hazardous wastes or types of those wastes. Focusing on SQGs may be a consequence of a program's focus on RCRA hazardous wastes. SQGs have only recently been subject to regulations under RCRA, and there has been a concentrated effort by EPA to inform such RCRA hazardous waste generators of their new responsibilities. Part of that effort has included making funds available to States for SQG projects (see below).

There is uncertainty about the amount of RCRA hazardous wastes being generated by SQGs. In 1982 OTA estimated that SQGs represented "from less than 1 percent to over 10 percent" of States' RCRA hazardous waste generators and the figures for most States were at the low end of the range.[18] According to an EPA study, however, SQGs produce less than 0.5 percent of the hazardous wastes annually, although they represent 98 percent of the Nation's total number of generators.[19] Statistics produced at the regional or State level can also vary. In a 1986 report covering New England, eight RCRA waste streams were compared. Depending on the waste streams, small generators produced between less than 1 percent and a high of 8 percent of the wastes.[20] On the other hand, according to statistics from Massachusetts, SQGs produce 25 percent of the State's RCRA hazardous wastes.

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[15] Kim Wilhelm, Waste Reduction Unit, California State Department of Health Services, personal communication, Apr. 30, 1986.

[16] Small quantity generators are defined by RCRA regulations as those which produce (or accumulate) between 100 and 1,000 kilograms per month of hazardous wastes. Since March 1986, they have been regulated under Subtitle C of RCRA. Generators which produce less than 100 kilograms per month are called "very small quantity generators" and are not covered by regulations.

[17] Minnesota Technical Assistance Program, promotional flyer.

[18] U.S. Congress, Office of Technology Assessment, "The RCRA Exemption for Small Volume Hazardous Waste Generators," staff memorandum, July 1982, p. 20.

[19] U.S. Environmental Protection Agency, *National Small Quantity Hazardous Waste Generator Survey* (Washington, DC: Office of Solid Waste, February 1985), p. 2.

[20] New England Congressional Institute, *Hazardous Waste Generation and Management in New England* (Washington, DC: February 1986), table II-4. In this study a small generator is defined as one producing 5,000 or less kilograms of waste per year.

Funds for Small Business and SQGs

Targeting of small business and SQGs by State programs has been supported by EPA. For example, Georgia's Hazardous Waste On-Site Consultation Program received $50,000 (66 percent of its budget) in 1984 to 1985 from EPA's Small Business Ombudsman Office and $200,000 (90 percent) in 1985 to 1986 from EPA's Office of Solid Waste. Georgia's program, as a consequence of this funding and perceived State needs, concentrates its efforts on bringing SQGs into voluntary RCRA compliance; and waste reduction is a relatively minor component.[21] The State has assumed full funding of the program for fiscal year 1987, and the program may eventually broaden its target population.[22]

Funds have also been made available from EPA's Office of Research and Development in Cincinnati. The Hazardous Waste Engineering Research Laboratory has funded two Small Business Initiative projects in fiscal year 1986 through State waste reduction programs (North Carolina and Minnesota). Minnesota's MnTAP will administer $100,000 in grants on applied research projects to assist small business in complying with regulatory problems. The grants will apply primarily to RCRA hazardous waste and will not be restricted to waste minimization.[23]

Section 8001 of RCRA allows for funding of special hazardous waste projects.[24] In fiscal years 1985 and 1986, $4.5 million has been dispersed via EPA's Regional offices to States, local governments, and other nonprofit entities. The largest group of projects receiving funding were those designated for SQG education and assistance projects. The State of Tennessee, however, used its fiscal year 1985 grant to fund a pilot technical assistance waste reduction program. Funds requested in 1986 to continue the project for another year were denied by EPA's Region 4. This Tennessee effort is one of only a few Section 8001 projects dealing specifically with waste reduction.

Budget Size

Funding for the 10 State waste reduction programs identified by OTA totaled about $7 million in fiscal year 1986, **but less than 50 percent of that money is for waste reduction**.

Individual State waste reduction programs tend to have small budgets because they are new and experimental and must compete with pollution control programs for funding. Budgets for *all* activities range from $40,000 to almost $2 million, when research funds are included. Waste reduction expenditures are estimated at less than 10 to over 50 percent of program budgets. Budgets are especially small in comparison with the total amounts spent by States' environmental control programs. In its fiscal year 1986, California budgeted $114.5 million of its own resources for its air, water, and solid waste programs. Another $50 million was spent at the local level in California for air quality programs.[25] Minnesota, with a $235,000 waste reduction program, budgeted $6.6 million in State funds for its water quality, air, and RCRA programs for fiscal year 1986. In addition, these latter programs received $5.1 million from the Federal Government.[26]

Programs aimed at stimulating rather than regulating waste reduction do not and will not require budgets comparable to those needed by

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[21] It is modeled after the Occupational Safety and Health Administration's "Section 7(c)1" consultation program which began in 1975. Under this program employers can ask for an OSHA paid consultant to offer advice about how to meet regulations. The consultants are not inspectors, and there is no threat of citation or penalty. [U.S. Congress, Office of Technology Assessment, *Preventing Illness and Injury in the Workplace*, OTA-H-256 (Washington, DC: U.S. Government Printing Office, April 1985), p. 235.]

[22] John C. Nemeth, Chief, Environmental Health and Safety Division, Georgia Tech Research Institute, personal communication, Apr. 28, 1986.

[23] Jim Bridges, Project Officer, Hazardous Waste Engineering Research Laboratory, U.S. Environmental Protection Agency, personal communication, May 8, 1986.

[24] This source of funds is explored more fully in the RCRA section in ch. 5 of this report.

[25] Charles Shulock, Environmental Affairs Agency, State of California, May 14, 1986.

[26] John Claus, Director, Administration Services Section, Pollution Control Agency, State of Minnesota, personal communication, May 1, 1986.

regulatory pollution control programs. But, to balance the pollution control culture which has evolved over the last 15 years, more than the current 1 percent or less of environmental budgets *will* be required. *No* Federal funds were budgeted for waste reduction in fiscal year 1986, while EPA's budget for its pollution control air, water, and RCRA programs totaled $732 million.

Small budgets for waste reduction do not just reflect the fact that awareness of the issue of waste reduction is recent. **The level of funding for waste reduction also indicates that it has little status as a solution to environmental problems.** State studies conducted to determine RCRA facilities' needs have tended to show that waste reduction methods would have a relatively modest effect on the generation of statewide RCRA hazardous waste streams (see ch. 3). In addition, strong competition is offered by traditional State environmental regulatory programs that are immersed in the pollution control culture. Such programs receive explicitly designated funding through the Federal RCRA, air, and water programs, while waste reduction does not. As the availability of Federal funds decreases, the States must increase their share of program costs; and the traditional regulatory programs are given priority.

The most common reason cited as an explanation of why States do not have waste reduction programs is lack of funds. Many State officials interested in waste reduction claim they are barely able to keep the currently mandated RCRA and Superfund programs going, much less add a new program. State officials have suggested that if the Federal Government would delegate funds for waste reduction they would then institute such a program. This feeling that the States are being overwhelmed by current Federal regulatory programs was echoed by participants at an OTA meeting with State waste reduction program officials.[27] [28]

Small budgets can actually be a benefit to State programs in their initial stages because they require relatively little justification for continuation. Designing and maintaining small programs prevents an increase in tension among waste reduction advocates and local industry, existing regulatory programs, and siting proponents.

New, relatively small budget programs, however, often are targets during budget-cutting periods. The Wisconsin Fund has been granting funds to local communities in that State for solid waste planning since 1978. In 1984, legislation was passed to allow the fund to cover and to give priority to local waste reduction and recycling planning efforts. The first waste reduction and recycling grants—a total of $242,000—were funded in January 1986. In February 1986 the legislature withdrew all of the remaining money in the fund because of general budgetary constraints in the State.

State people point out that small budgets and their corresponding small programs are not necessarily indicative of the support and resources given waste reduction at the State level. State governments are complex; they contain a multitude of administrative and legislative offices as well as advisory committees and boards. Environmental boards composed of State officials serve as internal coordinating bodies; those made up of private citizens serve in oversight roles and provide external support and an influx of ideas. (See ch. 2 for a discussion of waste reduction boards.) Any of these State entities can provide elements of support and can also present obstacles to State waste reduction programs. Most programs cite the environmental regulatory program offices as their major source of information and data, and in some cases regulatory program staff refer firms to waste reduction programs. State business support agencies are also useful. Minnesota's program, for instance, works through the established network of eight Small Business Development Centers across the State to enhance its outreach efforts.

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[27] The OTA meeting (Apr. 22, 1986) was held in conjunction with the Third Workshop for State Waste Reduction Programs in Washington, DC.

[28] See also testimony by the Association of State and Territorial Solid Waste Management Officials before the Subcommittee on HUD-Independent Agencies of the U.S. House of Representatives, May 8, 1986.

Nonregulatory Framework

Most programs operating now provide voluntary services to industry and are strictly nonregulatory. Some have considered or are considering the use of regulations in the future. California describes its program as one combining voluntary and regulatory aspects. Massachusetts, where a waste reduction program was just getting underway as this report was being written, is the only State that has decided to work through its regulatory system to promote waste reduction.

The State programs' nonregulatory approach may be essential for developing a consensus for waste reduction. It allows promoters to sell the industrial community the concept that avoiding the generation of pollutants is in their economic interest while defusing concern over government interference in internal operations. Many see their ability to work cooperatively with industry impaired if they operate from a regulatory mode because the existing regulatory/industry atmosphere is adversarial. The major goal of most State programs as they are now set up is not to regulate but to increase industry's awareness of the potential of pollution prevention. However, it is the cost of complying with existing regulations that often motivates industries toward considering waste reduction techniques and investigating waste reduction assistance offered by State programs.

The State of Massachusetts, after a number of years of studying the possibilities of promoting waste reduction through the imposition of new economic incentives and disincentives, has decided instead to operate within the current regulatory structure and programs. Thus, the State's lead Source Reduction Program is located in its regulatory Department of Environmental Quality and Engineering but outside of the department's media programs (such as the Solid and Hazardous Waste, Air Quality, and Water Pollution Control Divisions).[29] It is studying ways to help the regulatory people use the flexibility of current statutes and regulations to apply waste reduction within a multimedia framework.

Whether a regulatory or nonregulatory approach at the State level will be more effective in promoting waste reduction to industry is debatable. It is too early to tell from State experiences: no programs have yet collected supporting data and the only two using regulatory approaches are embryonic. Massachusetts is still planning how it will use the existing regulatory structure.[30]

The regulatory environment can limit capabilities. The California program is located within the State RCRA regulatory program office and operates under two regulations—land disposal restrictions and an expansion of the Federal waste minimization reporting requirements. The program also offers regulatory compliance assistance to RCRA generators. Its technical assistance effort does not offer onsite consultations because of a concern that its staff would be obliged to report any noncompliance with RCRA regulations that they might happen to witness. The North Carolina program, on the other hand, successfully operates out of a regulatory agency because its staff have no regulatory powers.

The extent of the adversarial relationship between industry and government regulators varies across the Nation. In general, it appears to be more onerous between industry and the Federal Environmental Protection Agency than between industry and some State regulatory bodies. Whether waste reduction technical assistance staff (with or without regulatory powers) are invited into a plant site for consultation is determined by this relationship, the operating procedures of firms, the personality of plant managers or contact personnel, and firms' ability to the trust government regulators.[31]

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[29] Another source reduction project exists within the State's Department of Environmental Management which deals with land management issues. This group is still focusing on ways to educate industry about the benefits of adopting waste reduction practices through the use of seminars, workshops, and technical assistance brochures.

[30] The Source Reduction Program issued a draft report on "Promoting Source Reduction—Existing Regulatory Opportunities, Issues for Discussion" in May 1986. The intent of the report is to stimulate discussion of the possible components of the regulatory approach within the department.

[31] Other important factors are the need for services and the confidence of plant people in the expertise of the State technical assistance staff.

California and Massachusetts are considering other regulatory components for their programs. A California bill would create a voluntary registration process for independent environmental auditors. This bill, before the California Legislature in 1986, would create Environmental Quality Assessors (modeled after certified public accountants). This approach could increase the adoption of waste reduction techniques if the assessors were required to provide such assistance as part of their registration requirements. Supporters feel that this program could assist small and medium-sized businesses in gaining access to chemical management experts, thereby helping them "to achieve and maintain compliance with toxics laws and regulations and reduce long term liability."[32] The bill requires a minimal examination of applicants and those who pass will be placed on a referral list. While some individual firms in California have opposed the bill, several major industry groups such as the Chamber of Commerce and the California Manufacturers' Association are supporting it. Those opposed view the bill as a precursor to mandated environmental auditing.[33]

Massachusetts may require industrial firms to draw up annual waste reduction plans to be certified by State-approved engineers. The waste reduction plans would specify the steps taken to accomplish waste reduction at each point of release of each regulated substance in a plant. The theory behind such actions is that forced planning will point out material losses and increase awareness among firms of the potential of waste reduction. Legislation that includes such planning requirements has been introduced in Massachusetts and is being considered in 1986.[34]

Program Activities

A State can, theoretically, educate its industry about waste reduction by offering information and technology transfer services. It can encourage the adoption of waste reduction practices by removing disincentives (increasing the cost of waste management by adding waste end taxes, for example) or by instituting incentives (such as loan and grant offerings or feedstock taxes). It can support R&D to improve the technical opportunities for waste reduction. It can mandate that industry adopt waste reduction practices. Actual program component choices will be based on each State's perceived needs and available resources and the political feasibility of initiation and implemention.

Information and Technical Assistance

By and large States have adopted an education role, and the cornerstone of most existing State waste reduction programs is a technical assistance component. Nine States (California, Connecticut, Illinois, Georgia, Minnesota, North Carolina, New York, Pennsylvania, and Tennessee) have technical assistance programs (TAPs) which, in varying degrees, offer waste reduction advice to State industry. Some TAPs (such as those in Minnesota and Illinois) have been set up specifically for the purpose of offering a range of waste minimization assistance; some offer a broader range of technical advice to State businesses. An example is Pennsylvania's TAP which now includes waste reduction but has been offering technical assistance to State business (modeled after the agricultural extension service) for 21 years. New York's TAP covers solid, as well as hazardous, waste problems and offers waste minimization advice that includes a waste-information exchange service.

Minnesota's TAP is widely regarded as a model assistance program. It began operations in December 1984 and offers a call-in service and onsite consultations. A unique feature of the Minnesota TAP is its summer engineering intern program which expands its onsite consultation capability to long-term projects while training future engineers to be aware of a multitude of hazardous waste problems and solutions.

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[32] State of California, Commission for Economic Development, "Proposed Legislation, *Environmental Quality Assessment*, Senator Craven." Attachment to letter to Joel Hirschhorn, OTA, from Peter Diebler, Special Consultant to the Commission for Economic Development, Mar. 10, 1986.

[33] Peter Diebler, consultant to the Lt. Governor, State of California, personal communication, May 1, 1986.

[34] The Massachusetts Toxic Use Reduction bill, Section 8, Toxics Use Reduction Plans.

The TAPs so far appear to be largely reactive; initial contacts are responses to telephone and written inquiries. This method is an efficient use of small budgets and is in keeping with the voluntary nature of the programs. Its effectiveness in reaching a high percentage of State hazardous waste producers may depend on the strength of a complementary outreach effort.

TAP advice ranges from help with regulatory compliance problems to waste management and waste reduction. Appropriate technical information is supplied or other sources of information offered. For information outside the scope of the TAP, callers are referred to other State agencies (for assistance with loans or tax credits, for example) or to private firms offering needed services.

Onsite consultations result from requests by firms. Except for the program in Georgia (see above), the existing TAPs are limited to a small number of onsite consultations per year because of staffing levels. Depending on travel distances, an onsite consultation takes 1 or 2 days. A followup written report with suggested actions can take up to a month to prepare.

State programs also educate and expand the effectiveness of their TAP through **outreach**. Outreach is variously defined but generally includes promotional activities, such as speaking before trade associations and civic organizations. Seminars are conducted for specific industrial groups (e.g., electroplaters, dry cleaners) or may focus on specific waste streams (e.g., solvents, waste oils). Such activities can help State programs enlarge their constituency.

Governor's awards are used as an outreach device aimed at raising public awareness. They have been presented in North Carolina, Minnesota, and Tennessee and will be awarded for the first time in Kentucky in September 1986. The awards are generally given annually to firms that conduct laudable waste reduction or waste management projects. States appear to have difficulty in obtaining candidates after the first couple of years. If a State does not include a public relations effort to bring public attention to the awards, the cost to industry (especially to smaller firms) of entering may not seem to be worth the effort. When Tennessee first used the technique in 1986, the winners were mentioned in the local newspaper, but only on page six of the business section. Had any of those firms been suspected of creating a hazardous waste problem, they would have received front page attention.

Financial Assistance

Next to technical assistance, the second most prevalent program component at the State level is direct financial assistance to help override some of the costs of waste reduction or improve the technical opportunities for such projects. Financial assistance is offered in the form of loans or competitive research grants, some of which are on a matching basis. None of this assistance is offered exclusively for waste reduction projects; much covers RCRA hazardous wastes only.

Grants in North Carolina, Minnesota, and California in 1986 totaled approximately $1.5 million to industry (primarily small business) and academia for a wide range of projects. Only a portion of this sum—at the most 50 percent—will be used specifically for waste reduction. California's research, development, and demonstration grants, for instance, were established under the State's Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act of 1985. The act excludes from consideration only those treatment activities "occurring directly in, or on, the land, such as techniques using evaporation, surface impoundments, or land farming."[35] Minnesota's Hazardous Waste Reduction Grants are advertised as " . . . available to help investigate new waste reduction techniques—or the applicability of known techniques—to reduce waste generation."[36] Although this language appears to favor waste reduction at the source of generation, an analysis of the four awards in 1985 shows that two were waste reduction projects and two were volume reduction projects. The waste reduction projects investigated the feasibility of changing circuit board etchants to reduce the generation of wastes and reusing acid solutions. North Carolina's grants (which are reviewed below) are available for waste reduction and recycling projects.

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[35] Assembly Bill No. 685, approved September 1985.

[36] Minnesota Waste Management Board, "Hazardous Waste Reduction Grants" brochure and application form, undated.

California's first research, development, and demonstration grants were awarded in June 1986. Applicability for the grants is divided into two groups: the private sector and public agencies and universities. The private sector received 24 grants totaling over $800,000; the latter group's grants totaled $75,000. No breakdown of grants in terms of the ratio of waste reduction to recycling and treatment projects is available. One of the four categories of private sector grants (feasibility studies) is more likely to include waste reduction projects, according to program staff.[37] Just over half of the grants in 1986 are for feasibility studies.

The future of Minnesota's research grants program was in doubt in mid-1986 due to a combination of overall budget cuts in the State and a low rate of response to the program's second year offering.[38] Although 90 requests for applications were sent out, only two proposals were submitted. Depending on the worthiness of these proposals, the Waste Management Board may decide to fund them at a maximum of $30,000 each. The rest of the remaining grant budget (which originally totaled $150,000 for 1986-87) may be shifted to its MnTAP. The board is conducting an overall review of the grants programs. If a decision is made to continue the program, some changes probably will be made in the application procedure and in the program itself. For instance, the proposal process is apparently complicated and applicants feel they are not given enough time to complete it. The staff also feels that the cost of applying may be excessive in terms of the possible outcome, given the size of the grants (the maximum is $30,000).[39] The grants are restricted to generators of RCRA hazardous waste and capital equipment purchases are not allowed.

While the funds for Wisconsin's grant program to local communities were eliminated in 1986 (see above), the State has a smaller Waste Reduction and Recycling Demonstration Grant program, which began in 1986. Applications have been received totaling $1 million for the use of $350,000 that is available this year. In subsequent years, the program will have only $150,000 to disperse. None of the applications this year include proposals for waste reduction projects.

Tax credits for waste reduction are not widely available, and when they are, cover only RCRA hazardous wastes. North Carolina has a tax credit program that was originally established for recycling and resource recovery in the 1970s. The statute was recently extended to include "the costs of facilities or equipment to be used to reduce the volume of hazardous wastes generated."[40] Minnesota did offer a tax credit for pollution control and waste reduction equipment "used primarily to reduce the generation of hazardous waste . . . "[41] The credit only lasted 1 year due to an overhaul of the State's tax structure in 1985. No firm applied for the credit when it was available in Minnesota, and few have applied in North Carolina.[42] Purchases of waste reduction and

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[37] Jim Potter, Waste Reduction Unit, California Department of Health Services, personal communication, June 16, 1986.

[38] Wayne Sames, Manager, Planning and Technical Assistance, Minnesota Waste Management Board, personal communication, May 1 and June 11, 1986.

[39] It should be noted that North Carolina has had three successful rounds of awarding matching grants to industry since 1984. Its maximum grant has been $5,000 and that program's staff feels that $10,000 would be more appropriate. [Roger Schecter, Director, Pollution Prevention Pays Program, North Carolina Department of Natural Resources and Community Development, May 5, 1986.] California can award research grants with a $25,000 to $100,000 maximum. [Jim Potter, Waste Reduction Unit, California Department of Health Services, personal communication, June 16, 1986.]

[40] Roger Schecter, Director, North Carolina Pollution Prevention Pays Program, speech before the 1985 Triangle Conference on Environmental Technology, Raleigh, NC. Italics for emphasis.

[41] 1984 Minnesota Laws Chapter 644, Section 290.06. As cited in ICF Consulting Associates, Inc., *Economic Incentives for the Reduction of Hazardous Wastes*, prepared for the State of California, Alternate Technology and Policy Section, Department of Health Services, Dec. 18, 1985, p. 23.

[42] ICF Consulting Associates, op. cit., app. A, p. 24. ICF reported that since 1975 10 firms have been certified by the North Carolina Department of Human Resources for recycling, recovering, or reducing hazardous wastes and that the majority of these fa-

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recycling equipment are exempt from Wisconsin's 5 percent sales tax. Businesses in Wisconsin are now exempt from property taxes amounting to the worth of waste treatment equipment, and the State program is trying to extend this exemption to waste reduction and recycling equipment.[43]

Loan programs are available in a number of States. Among these are general loan programs that can be used for pollution control and, sometimes, waste reduction projects. Others have been specifically established to cover pollution control or, less often, waste reduction projects. Connecticut, because of a statute that established an assistance and advice program for small businesses on "the reduction, recycling or processing of hazardous wastes . . . ," can make use of existing general State loan programs.[44] New York, through its Industrial Financing Program, has had the authority since 1978 to provide loans to industry for multimedia pollution control projects, such as sewage treatment works, resource recovery facilities, and industrial hazardous waste facilities. The Environmental Facilities Corp., which administers the loan program, has proposed to the State legislature that a revolving loan fund be established by the State to "debt finance hazardous waste, solid waste, industrial waste reduction, recycling, treatment, and disposal projects at smaller companies."[45]

Information Collection for Program Effectiveness

There is no systematic information or data collection process underway in any State except Pennsylvania that assesses program effectiveness, and in no State is waste reduction being assessed. State programs explain this lack by saying that they are too new and too experimental to be able to ascertain at this stage what information is even appropriate. A key determinant of effectiveness is the amount of waste reduced over time. Some States have struggled with, but none have solved, the question of how to measure waste reduction on a statewide basis. This type of analysis is complicated by the number of factors (e.g., general economic conditions, State programs, existing regulatory programs, liabilities, and waste taxes) that may influence industry to reduce hazardous waste.[46]

State programs hesitate to require information—even when free services are offered—that would record progress, possibly because of their reluctance to intrude on the business community. For instance, in Minnesota's summer engineering intern program, six students each spent 4 months in 1985 working within a firm to develop a plan for a specific waste reduction project. North Carolina's program provides onsite technical assistance helping firms with waste audits or assessing the potential for a waste reduction project. Neither State program *requires* the benefactors of these services to supply specific followup data after implementation of the advice on projects' success or lack of success. Instead, they place the burden and cost of collecting such information on themselves. Because of limited program resources, the result is that they are simply unable to collect and assess appropriate information and data.

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cilities recycled hazardous wastes. The ICF report recommended (on p. R-5) that California not adopt the use of tax credits because they "do not address any specific barriers; unless allowable tax credits are high (e.g., greater than 50 percent), the amount of waste reduction directly attributable to the credit is likely to be low; and the costs of tax credits are difficult to control."

[43] John Reindel, Recycling Coordinator, Bureau of Solid Waste, Wisconsin Department of Natural Resources, personal communication, July 25, 1986.

[44] State of Connecticut, Public Act No. 85-542, enacted July 1, 1985. The Connecticut Development Authority also offers long-term industrial revenue bond financing for a variety of projects which include the purchase and installation of *pollution abatement equipment*. This bond program—unlike the former—is not restricted to RCRA hazardous wastes.

[45] Marian J. Mudar, Analyst, Industrial Waste Program, New York State Environmental Facilities Corp., personal communication, June 19, 1986.

[46] See ch. 4 for a discussion of appropriate measures for waste reduction.

NORTH CAROLINA, AN EXAMPLE PROGRAM

Since it is not possible for this report to present a thorough review of all eight State programs, OTA has chosen to present North Carolina's Pollution Prevention Pays Program (NC3PP) as an example. Although it conforms to many of the generalizations expressed above, it is unique in that *it is a multimedia program* which "addresses toxic materials, water and air quality, and solid and hazardous wastes."[47] *It focuses largely, but not exclusively, on waste reduction.*

The goal of the program is to "find ways to reduce, recycle and prevent wastes before they become pollutants"[48] (i.e., are disposed in some medium). To meet that goal, the program offers advice, provides information, and awards grants to firms, universities, and communities for waste reduction and for onsite and offsite recycling research, education, and demonstration projects. Waste treatment options are excluded from these activities because treatment tends to shift hazardous substances among media and because of possible overlaps with the activities of regulatory programs and the services of private consultants.

The NC3PP evolved over approximately 3 years out of a sequence of official State actions:

- **1981:**
  - —North Carolina Waste Management Act was passed by State legislature; established policy guidelines and the Governor's Waste Management Board.
- **1982:**
  - —State funded a 3P symposium,
  - —first Governor's Award was presented.
- **1983:**
  - —State funded pollution prevention Research and Education Grants through its Science and Technology Board,
  - —NC3PP position was created within the Department of Natural Resources and Community Development.
- **1984:**
  - —Legislature Research Study recommended establishment of NC3PP and defined its basic structure,
  - —authorizing bill established NC3PP and funded three full-time positions.

The original idea for the program came, however, from local environmentalists who were disappointed about the lack of success of both the fight against hazardous waste land disposal facilities and the campaign for good hazardous waste management practices. They proposed an alternative: if the concept *pollution prevention pays* could be institutionalized and waste streams reduced in the State, then many of the land disposal problems might be solved. They found listeners among State officials, including those within the North Carolina Department of Natural Resources and Community Development (DNRCD).[49]

While the idea for the program and sequence of State actions which created it are similar to other State experiences, the people who became involved in North Carolina did not view the environment from a media-specific perspective. The presence of such people at the early stages of development of the program shifted the focus away from an exclusive RCRA hazardous waste position to a multimedia approach. This perspective also helped to keep the program's operations focused specifically on waste reduction and recycling.

NC3PP components today include technical assistance, research and education, and financial assistance. The program received its first year's direct funding from the legislature in the summer of 1984[50] and filled its allotted three staff positions by January 1985. Most of 1985 was spent getting the program into full operation, especially its technical assistance component. The bulk of the program's conceptualization and planning had occurred previously within DNRCD and during the Legislative Research Study, and the first Research and Education Grants were awarded in 1983. In addition, the Governor's Waste Management Board has been presenting annual Governor's Awards for Excellence in Waste Management since 1982. These awards deal with RCRA hazardous and low-level radioactive wastes only.

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[47] North Carolina Pollution Prevention Pays Program, "1985 Program Summary and Status," January 1986.

[48] Ibid.

[49] This agency includes the regulatory programs for air and water; the RCRA program is located in the Human Resources Department.

[50] North Carolina operates under a July-to-June fiscal year.

So far, NC3PP has used both State and Federal Governments as sources of funding. The current annual budget totals $590,000 (see table 6-5). The State funds NC3PP through DNRCD and the Research and Education Grants through the Science and Technology Board in the Department of Administration. NC3PP provides the staff to administer and manage the board's grant program.

Technical Assistance

In its first year of operation in 1985, the North Carolina Program's technical assistance was conducted primarily by dealing with incoming telephone calls and written requests for information. While only 5 onsite visits were managed in the last half of 1985, the program hopes to conduct 15 or more in 1986. Waste reduction is the first option considered by staff when offering technical assistance.

Unlike generic hazardous waste problems, specific or unique problems can require individual research on the part of staff and may result in onsite consultations. Most firms prefer onsite visits by the staff, and the staff considers this to be the most valuable way of offering assistance to firms. However, such visits require substantially more time than telephone consultations. The program would like to have two persons instead of one assigned to technical assistance to have at least one person full-time for onsite consultation. However, present and foreseeable funding levels prevent this expansion of their service.

An information clearinghouse maintained by the program includes a library of relevant literature and has the capability of conducting data searches through a variety of databanks. An inhouse database is now being developed that will include literature, case studies, contacts, and Program publications.[51] The library is available to the public and is a particular favorite of engineering consultants.

Outreach, another aspect of technical assistance, consists of presentations by the staff to trade associations professional organizations, citizen groups, universities, and industrial workshops. The content and level of each presentation is tailored to the particular audience. A 10-minute slide/tape show giving an overview of the program is made available to groups. Workshops on specific industrial sectors or waste streams are organized and supported by funds from Research and Education Grants.

Research and Education

Using the Research and Education Grants awarded by the Science and Technology Board, the program promotes research projects and develops educational tools. Its objectives are to target North Carolina wastes and industries;

Table 6-5.—North Carolina Pollution Prevention Pays Program Funds

	1983-84	1984-85	1985-86	1986-87[a]
Program operation and challenge grants	—	$180,000	$190,000	$190,000
Research and education grants	$300,000	300,000	300,000	300,000
EPA Small Business Initiative	—	100,000	100,000	100,000
Total	$300,000	$580,000	$590,000	$590,000

[a] The State appropriates on a 2-year budget cycle, thus the 1986-87 funds were approved in the 1985 session of the legislature. The EPA 1986-87 funds, while part of a 3-year contract, are subject to review.

SOURCE: Office of Technology Assessment.

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[51] The most comprehensive, up-to-date bibliography on *pollution prevention* is published by NC3PP. The January 1986 issue contains 90 pages of citations (over 800 individual citations) broken down into two general, a miscellaneous, and 18 SIC category sections.

document the economic and technical feasibility of waste reduction; reduce in volume the State's hazardous, toxic, water and air waste streams; and develop innovative approaches to environmental management.

Research grants (using 1983 funds) were awarded for 13 university projects in 1984. The second round of these grants (1984 funds) was awarded in 1985 for 11 projects. For the third round, 34 proposals were received in 1986; 15 projects were funded. The overall makeup of each set of awards has varied as the program develops a better understanding of the State's needs and the importance of research and education to the program. Of the 15 projects in the recent round, 11 deal with waste reduction issues.

Financial Assistance

The program provides financial assistance primarily from its Challenge Grants with total available funding of $50,000 from the State and $50,000 from the EPA grant. Additional assistance is provided by referring firms to other State agencies that administer industrial revenue bonds and loans; the North Carolina Technological Development Authority which provides funds for new or improved products, processes, or services; and the Department of Human Resources, which provides a certification allowing firms to take advantage of special tax treatment. The latter resource is available only for those who purchase and install hazardous waste equipment for waste reduction, resource recovery, or recycling. It is not known how useful these services have been to industry or in promoting waste reduction.[52]

The Challenge Grants are awarded each year for a maximum of $5,000 which must be matched by the awardee. They are given to small businesses and communities for the development and implementation of waste reduction and recycling projects. The money cannot be used for operating or capital costs or detailed engineering design, and the project content must be transferable to other firms or communities in North Carolina. Sixteen grants were awarded in 1985 and an initial 13 in 1986. Of the recent group, nine are for waste reduction projects.

The program has no problem in attracting interest in its grants; 21 proposals were submitted for the 1986 round. The results are publicly available as "Project Summaries" and are used by the program in its technical assistance efforts. The program plans to use these results to help document its program justification report for the next State budget cycle. The Project Summaries clearly indicate the outcomes of the projects, explain whether they were successful or not, and discuss their transferability.[53]

Conclusions and the Future

The Pollution Prevention Program began with the objective of applying waste reduction and recycling techniques to North Carolina industry and waste streams and it has been deemed successful at meeting that objective. It now has a secure place within the State's environmental institutions. However, it will not grow in size in the near future due to the State's overall budget concerns. Any budget increases that become available will go to the environmental regulatory programs.

In general, the program is supported by both the environmental and industrial communities in North Carolina. The chamber of commerce organization in the State—North Carolina Citizens for Business and Industry—was one of the original supporters of NC3PP, helped to institutionalize it, and still strongly supports its activities.[54] **This business group feels that**

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[52] The tax certification can cause problems at the local level if it involves a hazardous waste management facility. Local communities believe that such firms should pay higher, rather than lower, taxes. [Bill Meyer, Chief, Solid and Hazardous Waste Management Branch, North Carolina Department of Human Resources, personal communication, May 8, 1986.]

[53] North Carolina has discovered that transferability of information *across industries* is limited by firms' tendency to view their own situation as unique, certainly unique to their trade. The Project Summaries encourage readership because they are brief, and because they are brief lack the specific detail that categorizes them as industry specific.

[54] Joe Harwood, Chair, Environmental Concerns Committee, North Carolina Citizens for Business and Industry, personal communication, May 9, 1986.

the program works because it is voluntary; that a mandatory approach would not be appropriate. The business group is now looking at the idea of adding a tax incentive in the State that will give some credit to firms that substantially reduce their wastes.

NC3PP does not make a conscious effort to target its activities toward small business concerns. There is no reason to target small quantity generators since they are part of the RCRA universe and NC3PP does not focus on RCRA hazardous wastes. An initial data collection effort identified (by number of facilities) the five major industrial categories of hazardous waste generators, air and water quality permittees, and industrial pretreatment programs. However, the Challenge Grants and use of the EPA funds are restricted to small business firms, and this group is the most likely to call for assistance. Large firms tend to be a valuable source of information to the program, but they are more open about sharing information on waste management, which tends to use generic technology, than on waste reduction, which can involve their own processes.

The program considers an expansion of its technical assistance to allow for more onsite visits to be its first priority, if additional funds become available. After 3 years of awarding research grants to State universities, the program staff sees a need to enlarge the pool of expertise. It may be difficult, however, to obtain the authority to allow competitive bidding outside of the university system. The State universities have become accustomed to the annual $300,000 infusion of funds and will oppose any change. The Challenge Grants are considered by staff to be too small and need to be doubled to $10,000 to enable more detailed work to be accomplished. It has been found that the once-a-year cycle for grants is not always appropriate, and the program is now holding back about $30,000 of this money for use as worthy projects are identified through its technical assistance work.

THE EFFECTIVENESS OF STATE PROGRAMS

As yet, there is little information available on which to base any evaluation of the effectiveness of State programs in achieving their stated goals or in reducing the generation of hazardous waste. It is not possible to judge at this time whether the technical or financial assistance offered by State programs actually encourages waste reduction. The programs do not appear pressed for accountability and do not collect information in a systematic way. Few have even defined their future information needs. Thus, even in the near future, it will be difficult to make objective program evaluations.

The fact that some State programs have been through and have survived several annual budget processes is an indication of success. But, as mentioned before, this has not occurred as the result of an objective review. Since these are small budget programs, justification requirements are not rigorous. Renewals can be based on the ability of those concerned to argue program benefits effectively, often using anecdotal evidence. Programs can also gather the support of their constituents to help them through the budget process. In general, industry tends to be supportive of State programs as they are currently constituted. This is especially true of those firms that have taken advantage of the services offered. On the other hand, some industry people support these small, nonregulatory programs because they serve as a bulwark against the advent of waste reduction programs that could involve standard setting and regulations.

If there is currently a wait-and-see attitude among those who control State purse strings, then the programs may eventually have to provide an objective review of their activities and the results of these efforts. California's program staff, with one of the largest budgets among the current State programs, considers this a likelihood. They feel that for their third budget request they will have to be able to show that waste streams in California have decreased, and they intend to obtain such information from their grants and technical assistance projects.[55]

The Minnesota Waste Management Board completed a draft evaluation report in August 1986 of its hazardous waste programs.[56] To assess the effectiveness of its technical assistance program, the board reviewed the TAP's activity level and reported the results of a survey of users of the service. While the TAP appears to have a very good image, no evidence was presented that shows that waste reduction has occurred as a result of its assistance. In fact, the board noted that: "The majority of MnTAP's assistance went to help generators understand and comply with hazardous waste regulations as well as helping them improve their waste management methods." As part of the evaluation of the board's research grant program, details of four 1985 projects were compiled. One of the two waste reduction projects funded—ADC Telecommunications—achieved a reduction of from 36 to 100 percent in wastes generated. At the maximum reduction rate, saved costs were estimated at $14,900 per year. The cost of the project, which involved changing a process etchant, was $15,300 of which the State contributed $11,300. The second waste reduction project was judged technically feasible but not economic on the small scale attempted.

The growing number of States that have established and planned programs over the last 2 years is one measure of success. It indicates success in selling the concept; it does not indicate a flurry of waste reduction activity. Considering the lack of attention given to collecting information, the growth in numbers of State programs cannot be taken as proof that even effective waste management is underway.

Three programs have conducted followup surveys to assess effectiveness. Pennsylvania's TAP conducts surveys on a continuing basis. Minnesota's TAP has surveyed its users twice; Georgia, once. None of these efforts tabulated or identified occurrences of waste reduction. The Minnesota program's first survey was in 1985. Fifty percent of the 150 firms to whom a survey was mailed responded. Most of the respondents (86 and 76 percent, respectively) were satisfied with the service or thought that the advice offered had aided their decisionmaking. Twelve percent of the respondents (6 percent of the survey population) reported that the assistance offered had resulted in wastes being minimized. It is not known how much of this minimization has been a reduction in the generation of wastes or how much has been a reduction in the volume of wastes being sent offsite for management. Pennsylvania's and Georgia's numerical evaluations are even less relevant in terms of waste reduction. Since waste reduction is not a major focus of either program, the information is not needed for program justification.

State programs do collect data on their *activities*. In New York, North Carolina, and Minnesota, TAP activity is tabulated. Thus, in 1984 to 1985 New York's program handled 219 technical assistance calls, made 44 onsite consultations, and made 31 promotional contacts. In 1985, North Carolina's program staff responded to about 900 telephone and letter requests for information. While records are kept of these contacts, no tabulation has yet been made and it is not known how many involved regulatory compliance or waste reduction or how many callers needed technical or grants information. Most importantly, it is not known whether the responses by the staff encouraged good waste management or waste reduction practices. Minnesota handled 320 telephone calls in 1985 and conducted 35 onsite consultations excluding those related to its intern program.

Eventually, more results from the grant programs will be publicly available; at this point it is too early to assess their effectiveness in increasing the potential for waste reduction. Minnesota's first grants were awarded in 1985;

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[55] Kim Wilhelm, Waste Reduction Unit, California State Department of Health Services, personal communication, Apr. 30, 1986.

[56] Minnesota Waste Management Board, "Hazardous Waste Programs Evaluation Report," draft, August 1986. This is a discussion document. The board's final report and recommendations will be made to the State legislature in November 1986.

North Carolina's Challenge Grants were awarded in 1985 and its Research and Education Grants in 1984. California awarded its first research grants in June 1986. No State has a system in place to aggregate and analyze the information provided by the grants.

WASTE REDUCTION: FEDERAL AND STATE COOPERATION

State programs will need to focus their activities on waste reduction if it is to become a significant factor in environmental protection at the State level and if they are to be effective in preventing pollution. At the same time, both the size of these programs and their share of overall State environmental activities will need to be increased. Shifts in focus or resources will require that a stronger political base of support for waste reduction be developed among State elected officials and regulators, industry, local communities, and environmentalists. Such support will be required to overcome the traditional attitude that pollution control is the only environmental protection strategy.

The Federal Government now offers limited support to State waste reduction programs with its waste minimization regulations and some grant funding. These activities, however, tend to encourage good RCRA hazardous waste management among small business rather than multimedia waste reduction throughout industry. **If national policy as stated in the 1984 RCRA Amendments is to be the Nation's goal in actuality—not only in theory—then the State programs will need a leadership role from the Federal Government**. In that role, the Federal Government could advance the primacy of waste reduction at the State level by a variety of activities, each of which has different political and budgetary costs (see ch. 2).

Current Federal Support

Since the passage of the 1984 RCRA Amendments, the Federal role in *waste minimization*, one component of which is waste reduction, has been minimal. The Federal role is regulatory and comprises the waste minimization regulations, which define certification and reporting or recordkeeping requirements for RCRA hazardous waste generators (see ch. 5). **Using OTA's minimum criteria developed to define State waste reduction programs, the Federal regulatory system does not qualify as a waste reduction program.**

The current system of regulations appears to have had little impact on State waste reduction programs and planning efforts; most were underway prior to the RCRA 1984 Amendments. In OTA's State survey, four States—Massachusetts, Illinois, Tennessee, and Connecticut—cited the amendments as one of many reasons for their waste reduction efforts. People involved in most State programs feel that the presence of the regulations has increased RCRA generators' awareness of waste minimization as an issue. At the same time, however, those generators are often confused as to what "having a waste minimization program in place" means. In Georgia, questions about the Federal waste minimization regulations now come up during seminars and the regulations are part of that State's program to assist generators with RCRA compliance. Minnesota's TAP has not noticed any major change in the office's incoming telephone queries. Only about five calls have been received in the last year requesting help with the Federal "waste minimization plan" requirement.[57] Those in the California program feel that the waste minimization manifest certification has prompted telephone calls and raised consciousness among generators. In general, the callers are confused as to the requirement of the manifest certification.[58]

If the outcomes of the Federal voluntary waste minimization program cannot eventually be assessed (see ch. 5), then its potential for being of assistance to State programs will be in doubt as well. As mentioned above, States are not collecting relevant waste reduction data. While the Federal regulations require that some RCRA generators submit certain information, its content is not relevant to determining the effectiveness of waste reduction. The biennial reporting statement is a narrative, is only made by generators who ship wastes offsite (ignoring those who produce and manage wastes onsite), and only covers RCRA hazardous wastes. Apparently, when EPA set up the reporting system it did not intend to make any use of the incoming information since the statements are not to be forwarded to EPA but are to remain at the State level.[59]

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[57] Cindy McComas, Director, Minnesota Technical Assistance Program, personal communication, Apr. 30, 1986.

[58] Kim Wilhelm, Waste Reduction Unit, California Department of Health Services, personal communication, Apr. 30, 1986.

While some State RCRA regulatory or waste reduction programs are looking into the possibilities of using or supplementing some of the information collected as the result of the Federal regulations, most are not. In answer to a question on OTA's State survey, one State felt that information sent in response to the reporting regulations should begin to provide them with data to assess the effectiveness of waste reduction. Minnesota's TAP is now considering how it might use the next set of waste minimization statements that result from that State's generator reports on 1986 activities.[60] North Carolina's RCRA program, which requires annual reporting by its generators, is planning to conduct a small number of followup visits to firms in selected industrial categories that have reported waste minimization activities to determine whether the statements are justified. The conclusions drawn from these visits will be part of a report to the State legislature requesting State waste minimization funds for the regulatory program. These activities will be coordinated with the State waste reduction program.[61] California is reviewing the statements provided in the Federal biennial reports covering 1985 with the intent of developing a waste reduction report from all its RCRA hazardous waste generators, as required by the State's Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act. Unlike the Federal system, California's will require waste reduction statements from generators who ship offsite and from those who manage their wastes onsite.

Generators in New Jersey who were required to complete the waste minimization section of the Federal report covering 1985 were provided with a separate survey designed by the New Jersey Department of Environmental Protection. The department—like all State RCRA offices nationwide—had no guidance from its EPA Region or from headquarters regarding the requirement. The State survey was not designed to gain consistent information from generators but was an attempt to forestall what the department feared would be a deluge of questions from generators asking what the narrative statement should contain. On the survey three questions each were asked regarding separation, substitution, efficiency, recycling onsite, and treatment onsite.[62] The responses, several thousand completed forms, were stored in boxes kept in the department since the waste minimization statement is viewed in New Jersey, as elsewhere, primarily as a device to increase awareness rather than as an information collection procedure.[63] The New Jersey Source Reduction and Recycling Task Force (of the Hazardous Waste Facilities Siting Commission), which became aware of the surveys after they were collected, is now planning to use them as a possible source of information in their planning for a waste reduction program for the State.[64]

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[59] This is true unless a State does not have RCRA authorization. In such cases EPA regions distribute and collect the biennial reporting forms. See ch. 5 for details of this regulation.

[60] Cindy McComas, Director, Minnesota Technical Assistance Program, personal communication, Apr. 30, 1986. It should be noted that while the Federal system only requires biennial reporting, Minnesota, like many other States, requires annual reports. The State, in conducting the 1985 Federal reporting, inadvertently failed to include the waste minimization section.

[61] Bill Meyer, Chief, Solid and Hazardous Waste Management Branch, North Carolina Department of Human Resources, personal communication, May 8, 1986.

[62] Generators were warned that in future reports actual, rather than estimated, amounts of volume reductions would be required.

[63] Nancy Power, Administrative Analyst, Bureau of Manifest and Information Systems, New Jersey Department of Environmental Protection, personal communication, Apr. 30, 1986.

[64] Susan B. Boyle, Assistant Director, New Jersey Hazardous Waste Facilities Siting Commission, personal communication, May 1, 1986.

The Federal regulations may help State programs by increasing an awareness of waste minimization—**but not necessarily waste reduction**—in industry. This may occur if those who sign the manifest certification, fill out biennial reports, and maintain operating records are the same people who design and maintain waste generating processes and equipment. It is more likely to occur in the small firms that States target for assistance, firms in which occupational duties are not as narrowly defined as in large firms. However, as discussed in chapter 5, **the waste minimization regulations lead industry toward the avoidance of land disposal and not necessarily to waste reduction.**

In addition to its regulatory support, EPA has helped to fund some State programs. Two sources of funding have been a Small Business/Small Quantity Generator Initiative program in the Office of Research and Development (ORD) and Add On Grant funds authorized by Section 8001 of RCRA, some of which were designated for outreach to SQGs. The ORD program gave out about $325,000 in fiscal year 1986 of which $200,000 went to the North Carolina and Minnesota programs for research grants. The Section 8001 funds provided $4.5 million in fiscal year 1986 to State and local RCRA activities. Some of this money was applied to SQG outreach that included waste minimization projects. (These funding programs are discussed more fully in ch. 5.)

State Program Needs

When State program people are asked what they need to increase their effectiveness they invariably answer: an increase in professional staffs. Programs that offer technical assistance would like to provide more onsite consultations. The number of outreach efforts (e.g., seminars, brochures) are viewed as too few. Current low staff levels, a consequence of low budgets, are referred to as an explanation of why there is no effort directed at program evaluation.

States need publicly expressed support for waste reduction from their Governors, but this does not always happen. This need seems analogous to the need expressed by environmental management people in large corporations for top-down or CEO support. Such backing provides visibility and visibility leads to clout. It enables small entities to increase their influence within their operating environment. However, a Governor who publicly supports waste reduction runs a risk of being identified as antibusiness unless there is broad understanding of the environmental and economic benefits waste reduction confers.

State people are ambivalent about the prospects for Federal Government support for waste reduction. On the one hand they recognize that State programs need an infusion of money and the visibility that a Federal program could provide. But, the Federal Government is not seen as a reliable funding source today. It has been reducing support in many areas, leaving States to provide their own funds for popular programs, and the prospect of switching from State to Federal sources for funding is now seen as risky. Should the Federal Government decide to offer any type of financial support for waste reduction, a system of matching funds could provide continuity by requiring the continuing involvement and interest of State legislatures.

At the same time State staffs are protective of the gains for which they have fought. In general, these are the people who have guided program development from the conceptual stages. They are proud of their innovations in designing programs tailored to State needs and of the initiatives undertaken to institutionalize them. **States do not want a johnny-come-lately Federal program which will specify program content from a national perspective and require a redirection of their efforts.**

Appendixes

Appendix A

The OTA Industry Survey

In order to gather some quantitative data about industry's perspectives on hazardous waste reduction, OTA conducted a survey of industry personnel in February and March 1986, which asked questions about how and why waste-related decisions are made. The survey was administered to all participants in two OTA Industry Workshops. In addition, it was mailed to 108 industry personnel in a variety of industries that use hazardous substances. (That is, the survey was given to 141 people.) All of the respondents were people who had previously shown some interest in hazardous waste reduction and all were involved in some way in waste decisions made at their company. The survey sample was not, therefore, random. Over 85 percent of respondents had technical backgrounds. A special attempt was made to elicit responses from small and medium-sized businesses.

Ninety-nine completed responses were received (a 70 percent response rate) from companies in more than 20 States; 43 were received from small to medium-sized companies and 56 from large corporations. Eleven Standard Industrial Classifications (SIC) are represented in the OTA sample (see table A-1). The large number of chemical company respondents reflects the fact that chemicals and allied products (SIC 28) is responsible for approximately 50 percent of the RCRA hazardous waste generated in the country.

Table A-1.—Distribution of Respondents to OTA's Industrial Survey

SIC number	Short SIC title	Number of respondents in OTA survey
22	Textile mill products	2
26	Paper and allied products	1
28	Chemicals and allied products	34
29	Petroleum and coal products	5
30	Rubber and miscellaneous plastics	3
33	Primary metals industries	3
34	Fabricated metal products	16
35	Machinery, except electrical	8
36	Electric and electronic equipment	10
37	Transportation equipment	9
38	Instruments and related products	6
39	Miscellaneous manufacturing	1
unknown		1
	Total	99

SOURCE: Office of Technology Assessment.

The survey form was divided into three parts. Part 1 requested information about the type, size, and location of the respondent's company; Part 2 dealt with current waste reduction efforts in the company; and Part 3 asked for the respondents' views on future waste reduction efforts, both in their company and by government. Only four respondents, two from small businesses and two from large business, left Part 2 blank on the grounds that they have undertaken no waste reduction efforts in their plants. A copy of the survey follows this discussion.

When questioned about the importance of different factors that affect the pace and extent of waste avoidance efforts (Q. 2-1), *respondents clearly ranked the rising costs of waste management and the increasing difficulties in using land disposal as the two most important factors.* Scarcity of technical information about waste reduction and the failure of top management to make reduction a high priority were rated least important in spurring or slowing waste reduction.

Similarly, when asked about circumstances that have an important impact on waste reduction decisions (Q. 2-8), economic factors—costs, liabilities, need to increase productivity and improve product quality—and regulatory requirements were rated more important than improving public and consumer perceptions of the company.

When asked specifically about obstacles to waste reduction efforts (Q. 2-4), economic factors—the dollar value of benefits from waste reduction and the costs of carrying it out—were rated the most significant barriers by all respondents. However, small businesses were almost twice as likely as large companies to cite other obstacles, such as the nature of the waste streams (15 percent of small businesses, 7 percent of large) and the costs of managing specific wastes (23 percent of small businesses, 15 percent of large).

Among waste reduction activities implemented to date (Q. 2-6), in-process recycling was ranked first, particularly by large companies. Changes in equipment or technology were ranked second, and improvements in housekeeping and general operations changes ranked third. Clearly the least used action of all companies responding to this survey was making changes in the final product(s).

Companies were divided in their responses to questions about the ways in which they plan waste reduction actions and target waste streams (Q. 2-5). When asked "are you more likely to focus on the weight or volume of waste rather than the specific threat or level of hazard of the waste?" 46 percent replied in the affirmative. Of those, most (76 percent) said that lack of information as to the degree of hazard of waste(s) was not a problem. While most respondents indicated that they gave "much attention" to all different kinds of air and water emissions, responses overall indicated that water emissions are somewhat more likely to receive attention than air emissions (Q. 2-7).

Respondents expressed some concern that not all actions undertaken in industry in the name of waste reduction are as environmentally beneficial or economically profitable as they may initially appear. Sixty percent agreed with the statement: "What might be hailed as a successful waste avoidance [reduction] effort by a company may be misleading as to its environmental or economic benefits."

When asked about existing Federal waste reduction activities, specifically EPA's recent RCRA waste minimization certification requirements for waste generators which appears on manifests (Q. 2-2), virtually all respondents were familiar with them (only 3 percent not familiar) and 40 percent said that these requirements have prompted them to increase waste reduction. Uncertainty about EPA's or States' regulations and enforcement were not considered likely to hamper future waste reduction by most respondents (71 percent), although small companies were more likely to find that such uncertainties limit their action than were large companies. Thirty-five percent of small companies and only 25 percent of large companies said their waste reduction efforts would be limited by uncertainties about regulations (Q. 3-5).

Respondents were then asked to consider a variety of types of Federal waste reduction programs and evaluate their impact on waste reduction efforts in the respondent's company (Q. 3-1). Programs which respondents indicated would have the greatest positive impact on waste reduction were, first, a tax credit for capital spending on waste reduction and, second, reduced possibilities for land disposal through enforcement of RCRA programs. Following close behind were such considerations as increasing Superfund liabilities and technical information and assistance programs of various kinds. Potential programs that were rated as having little positive or no significant impact were: 1) presidential awards for outstanding waste reduction efforts, 2) Federal grants for State waste reduction programs, and 3) a mandated Federal waste reduction schedule. Respondents also clearly indicated (84 percent) that a Federal information collection program which would require regular reporting by industry on toxic chemical generation would not stimulate more waste reduction (Q. 3-9).

When asked specifically about the possibility of mandated reduction levels (Q. 3-4), small and large businesses gave very different responses. Seventy-five percent of large companies said such a program "would be difficult to implement and enforce and, therefore . . . would be of little use, have little effect, and might hamper our efforts." Only 47 percent of small companies chose this response. Instead, more than half responded that mandated reduction "would bring more attention to the issue and motivate industry to avoid the generation of waste." *Overall, 62 percent of respondents opposed mandated reduction.*

A similar split appears in responses to a question about further Federal Government action (Q.3-2):

> Overall, with regard to waste avoidance [reduction], if you had your way would you want the Federal government to a) leave things just the way they are now or b) take some further action to assist industry to carry out more waste avoidance [reduction] activities?

Sixty-seven percent of small business respondents favored further Federal Government action; only 50 percent of large businesses did. Overall, 57 percent of respondents favored some further action by the Federal Government to assist industry in waste reduction.

However, when asked whether this further government action should be carried out by the States or by the Federal Environmental Protection Agency (EPA) (Q.3-3), small business respondents clearly favored State action (67 percent in favor). The reason most often cited for this preference was that a State government has a better understanding of the particular needs of businesses in the State than does the Federal EPA and can be more flexible in dealing with problems. Large business respondents were more evenly divided between State v. Federal action. Those preferring Federal action stated that they found it easier to deal with one uniform program for all their operations than with a variety of State programs. Overall, 58 percent of respondents preferred State action to Federal action.

When questioned about current State waste reduction programs (Q.2-3), 43 percent of respondents said that State programs had affected their waste reduction efforts thus far. But only 24 percent of these believed that the State program had served as some form of subsidy or aid without which their waste reduction effort would have been less.

When respondents were asked to rank the importance of different waste reduction activities in *future* waste reduction (Q.3-7), the results were similar to the rankings they gave to activities in current waste reduction. Housekeeping and operations changes dropped somewhat in importance, leaving in-process recycling and equipment and technology changes as the important strategies for future reduction. Final product changes and raw materials changes were still at the bottom of the list.

A large majority of respondents (84 percent) estimated that current and likely future waste reduction efforts would have no effect on or might increase their company's employment (Q.3-8)

Finally, respondents were asked to estimate changes in their capability to avoid generating hazardous waste (Q.3-10). They were asked: "Using best available technology in *1980*, how much (by weight) of the hazardous waste (all types in all types of environmental media) generated by your operation in 1980 could have been avoided?" Fifty-nine percent responded "less than 25 percent," 30 percent responded "25 to 50 percent," and 11 percent responded "50 to 75 percent." When asked:

> Using best available technology in *1985*, how much (by weight) of hazardous waste (all types in all types of environmental media) generated by your operation in 1985 could have been avoided?

answers shifted slightly upward (15 percent responded 50 to 75 percent reduction possible). OTA could discern no pattern among the 10 to 15 percent of companies indicating that large amounts of waste reduction were possible.

SAMPLE COPY OF OTA'S INDUSTRY SURVEY

INDUSTRY PERSPECTIVES ON HAZARDOUS WASTE AVOIDANCE

Important Definitional Note:

In completing this survey, please keep in mind the following. The OTA project is concerned only with those actions taken by waste generators to avoid the generation of, management of, and introduction into the environment (external to plant operations) of any hazardous materials. In this survey we use the term "waste avoidance" to refer to such activities. When a broader scope of activities (including waste avoidance and better ways of managing wastes or the use of offsite recycling/recovery) is meant, we use the term, "waste reduction." Note also that OTA is also concerned with all types of hazardous wastes, emissions, and discharges into all environmental media.

Part 1: Although none of these results will be linked to a specific individual or company, some information about you and your company will allow us to better interpret all the responses:

1-1: Check off one of the following that most closely describes your situation:

a) _____ I am a technical person (i.e., a science or engineering background) involved in plant operations
b) _____ I am a technical person in a mid-level management position
c) _____ I am a technical person at the corporate rather than plant operations level
d) _____ I am a non-technical person at the corporate level
e) _____ other. Please explain briefly:

1-2: With regard to your company's efforts to avoid generating waste:

a) _____ I make decisions leading to actions
b) _____ I make recommendations to others for decisions
c) _____ other. Please explain briefly:

1-3: Your operation is best characterized as:

a) _____ small or medium sized company
b) _____ large company with corporate technical resources on which to draw
c) _____ other. Please explain briefly:

1-4: With regard to what your company does primarily:

a) Its SIC number is __________

b) Its chief products or outputs are: ____________________________

____

c) Something else you think relevant:

1-5: Your principal activity is in the State of ____________ in which there is, as far as you know (check off as many as apply):

____ no waste reduction program
____ a technical assistance program for waste reduction
____ an information transfer program for waste reduction
____ some type(s) of tax on your hazardous waste
____ some type of awards program for waste reduction
____ some other governmental effort concerning waste reduction, please explain briefly:

1-6: Because Congress required EPA to prepare a report on waste reduction, EPA has had several contractor studies underway. Have you or your company participated in any of these studies or surveys:

____ no ____ yes ____ don't know

Part 2: Factors which now are relevant and important to your efforts:

THE FOLLOWING SECTION ASSUMES THAT YOU HAVE UNDERTAKEN WASTE AVOIDANCE EFFORTS WITHIN THE CONFINES OF YOUR PLANT OPERATIONS. IF THIS IS NOT THE CASE, SKIP TO SECTION 3, PAGE 5.

2-1: Consider the following nine statements concerning factors that may already have affected the pace and extent of your waste avoidance efforts and give each statement one of the following evaluations:

1 = usually true in your operation
2 = occasionally true in your operation
3 = rarely true in your operation

_____ the capital costs of major waste avoidance efforts can not now be justified in economic terms in comparison to other capital projects in the company

_____ government environmental regulations accomplish enough, and lead to whatever attention we can give to dealing with hazardous waste issues

_____ we don't have enough detailed technical information on what to do for waste avoidance nor the resources to get more information

_____ top management hasn't given waste avoidance a high priority

_____ our technical staff is too small or too preoccupied with other more important jobs to give attention to waste avoidance

_____ the physical nature or age of our operation does not allow us to increase our waste avoidance efforts

_____ the rising costs of managing our wastes have made increasing waste avoidance efforts a high priority

_____ the difficulty of using land disposal for our hazardous waste has been an important catalyst to waste avoidance in our operation.

_____ public awareness and attention to wastes, emissions, discharges, accidental releases to the environment have not been relevant to our decision-making about waste avoidance.

2-2: With regard to EPA's recent RCRA certification requirements about waste reduction for waste generators such as appear on manifests (check those applicable):

_____ I am not familiar with them
_____ they have not posed any problem
_____ they have caused us to increase our waste avoidance activities
_____ other. Please explain:

2-3: Have State programs affected your waste avoidance efforts?

a) _____ yes _____ no

b) If yes, please indicate briefly what those program(s) were:

c) If yes, do you believe that the State effort was in some sense a form of subsidy or aid for your waste avoidance efforts without which your effort would have been less?

_____ yes _____ no

2-4: Have your waste avoidance efforts been held back because you lack enough detailed information on:

a)	the nature (e.g. degree of hazard) of your hazardous wastes	___ yes	___ no
b)	the costs of managing specific wastes	___	___
c)	the costs of carrying out waste avoidance	___	___
d)	the dollar value of benefits (other than avoiding waste management costs)	___	___

2-5: In planning your waste avoidance actions and targeting waste streams, are you more likely to focus on the weight or volume of waste rather than the specific threat or level of hazard of the waste?

____ yes ____ no

If yes, has lack of information on degree of hazard of your waste(s) been a problem?

____ yes ____ no

2-6: Of the waste avoidance activities which you have implemented to date, rank the following five broad approaches in terms of their importance (1 = the most successful approach):

____ changes in process equipment or technology
____ improvements in "housekeeping" or general operations
____ changes in raw materials used in operations
____ in-process recycling/recovery
____ changes in the final product(s) produced

2-7: When speaking of waste reduction most people focus on solid, hazardous waste associated with RCRA regulation. Consider the following other types of hazardous "waste" and indicate the level of attention your company is giving to reducing them. Use the following:

1 - much attention, action already or specific plans;
2 - a little attention;
3 - no attention at present;
x - not a relevant waste

a) routine toxic air emissions ____
b) accidental toxic air emissions ____
c) unregulated discharges of hazardous materials to surface waters ____
d) regulated discharges to surface waters ____
e) discharges of hazardous materials to sewers ____

2-8: Rate the following circumstances with regard to their direct or indirect impact on your waste avoidance decisions and activities to date (1 - most important):

__ an interest in improving public and consumer perceptions of the company

__ overall need to reduce costs, increase productivity, or improve product(s)

__ actual and perceived regulatory demands, costs, and liabilities

Part 3: Where do we go from here?

3-1: Consider the following eight potential types of Federal programs and, assuming that they would be done well, evaluate their potential impact on your waste avoidance efforts by giving each one of the following:

1 - would have a major positive impact;
2 - would have a small but positive impact;
3 - would not be a significant factor

____ technical information on specific waste avoidance approaches is made available free to you

____ free technical assistance especially designed for your operation to help develop your waste avoidance effort is made available to you

____ some type of tax credit or advantage is made available to you for capital spending on waste avoidance

____ a specific Federal requirement is mandated for a certain amount of waste reduction over a specified time as compared to some base year of waste generation

____ Presidential awards are given annually for outstanding waste reduction efforts

____ Federal grants are made to States for whatever programs they want to use to enhance industrial waste avoidance efforts

____ through RCRA regulatory programs and their enforcement, the use of land disposal is greatly reduced and all waste management costs increase still more

____ under the Superfund program, waste generators face increasingly greater burdens to pay for cleanups of toxic waste sites either offsite or onsite

3-2: Overall, with regard to waste avoidance, if you had your way would you want the Federal government to:

____ leave things just the way they are now

or

____ take some further action to assist industry to carry out more waste avoidance activities?

3-3: If the government did decide to take some further Federally mandated and funded actions, would you prefer to have them implemented by those States that wanted to have a waste reduction program or by the Federal EPA?

_____ the States ____ Federal EPA

If you prefer a state program, explain briefly:

3-4: If some Federally mandated schedule to carry out specific amounts of waste reduction on a plant or company basis were established, and if that schedule was industry-specific and gave credit for past reduction efforts, do you believe that

____ it would bring more attention to the issue and motivate industry to avoid the generation of waste

or

____ it would be difficult to implement and enforce and, therefore, it would be of little use, have little effect, and might hamper our efforts

3-5: Will your future waste avoidance activities be limited to a significant extent by your uncertainties about EPA's and your State's environmental regulations and their enforcement?

____ yes   ____ no

3-6: What might be hailed as a successful waste avoidance effort by a company may be misleading as to its environmental or economic benefits. Do you agree?

____ yes   ____ no

If yes, could you briefly explain why you agree:

3-7: Considering your future waste avoidance efforts, rank the following five broad approaches as to their expected importance (1 = most important):

____ changes in process equipment or technology
____ improvements in "housekeeping"or general operations
____ changes in raw materials used in operations
____ in-process recycling/recovery
____ changes in the final product produced

3-8: Considering what you hava done already and what you might do in the future, which of the following is most correct

_____ waste avoidance in our company will either have no effect on our total employment or might increase it

or

_____ waste avoidance in our company will reduce employment.

3-9: There is interest in adopting at the Federal level some type of requirement to have EPA conduct an inventory of hazardous waste generation (in its broadest multimedia terms) by industry, similar to what New Jersey has done on one occasion. Would such regular reporting by industry of all of its toxic chemical generation stimulate more waste avoidance by your company?

____ yes   ____ no

3-10: Please evaluate the potential for waste avoidance in your industry in the following two situations:

a) Using best available technology in 1980, how much (by weight) of the hazardous waste (all types in all types of environmental media) generated by your operation in 1980 could have been avoided?

____ less than 25% ____ 25% to 50% ____ 50% to 75%

b) Using best available technology in 1985, how much (by weight) of the hazardous waste (all types in all types of environmental media) generated by your operation in 1985 could have been avoided?

____ less than 25% ____ 25% to 50% ____ 50% to 75%

Appendix B

Waste Reduction: An International Perspective

The actions of other national governments in the area of waste reduction may be of interest to American policymakers for two reasons. First, the choices made by other countries can serve as policy models. The varied experience of countries actively promoting waste reduction and those attempting to deal with waste problems in other ways can help Americans understand the range of policies available to them and, over time, the results of those policies. Second, expertise gained by other nations with longer experience in waste reduction can present a challenge. Many Western European governments have actively encouraged waste reduction for many years. To the extent that their 10-year lead in waste reduction results in more efficient processes and increased productivity among European industries, U.S. firms in similar industrial sectors may be placed in an inferior competitive position. In addition, to the extent that a profitable worldwide market for waste reducing technologies and techniques opens up in the coming decade, U.S. firms may find it difficult to sell their waste reduction technologies to industrial operations here and overseas if Europeans are offering a wider variety of better techniques, tested over a longer period of time.

Multilateral Organizations

Some of the earliest initiatives in waste reduction came from international organizations. The United Nations Economic Commission for Europe (ECE) sponsored the first International Conference on Non-Waste Technology in Paris in 1976. In 1979 the ECE adopted a detailed "Declaration on Low- and Non-Waste Technology and Reutilization and Recycling of Wastes."[1] In this document, the ECE recommended action on both the national and international levels to develop and promote low- and non-waste technologies. International ECE activities resulting from this declaration have included:

- publication of a four-volume compendium on low- and non-waste technologies in 1982, listing over 80 examples of successful pollution prevention efforts by European industrial firms;[2]
- publication of a compendium of lectures by experts in low- and non-waste technology in 1983;[3]
- holding a European Seminar on Clean Technologies at the Hague in 1980;
- setting up a Working Party on Low- and Non-Waste Technology and Re-utilization and Recycling of Wastes which has met annually since 1980; and
- setting up an Environmental Fund for demonstration of innovative technologies that are broadly applicable to reducing pollution. A sum of 6.5 million in European Currency Units (about 6.1 million U.S. dollars) was set aside for this purpose in 1985.

The Organization for Economic Cooperation and Development (OECD) has taken a strong stand in favor of waste reduction although no promotional activities have been taken. An OECD conference in 1985 on transborder movements of hazardous waste concluded that the *first basic principle* for the management of waste is: "to prevent and reduce, so far as possible, the generation of wastes, to limit their hazardous character and to try to improve production processes." Recycling and proper treatment of wastes are included in the second principle. OECD further recommended that member countries make sure that: "adequate measures are taken for preventing or reducing the generation of hazardous wastes . . . " in new investment or development projects.[4]

European industry has also espoused the concept of waste reduction. In its recently published "Summary of Principles of Industrial Waste Management," the European Council of Chemical Manufacturers' Federations headed its list of principles with:

> . . . Waste reduction: Take all economically and technically justifiable measures to minimize generation of waste through process optimisation or re-design.[5]

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[1] United Nations Economic Commission for Europe, *Declaration on Low- and Non-Waste Technology and Reutilization and Recycling of Wastes* (Geneva, Switzerland: November 1979).

[2] Ibid.

[3] Hungarian National Authority for Environment Protection and Nature Conservation, *Compendium of Lectures on Low- and Non-Waste Technology* (Budapest, Hungary: December 1983).

[4] Organization for Economic Cooperation and Development, Resolution of the Council on International Cooperation Concerning Transfrontier Movements of Hazardous Wastes (including Appendix), July 3, 1985.

[5] European Council of Chemical Manufacturers' Federations, *Industrial Waste Management*, CEFIC, Brussels, Belgium, 1985. As cited in Royal Commission on Environmental Pollution, *Eleventh Report—Managing Waste: A Duty of Care* (London: Her Majesty's Stationery Office, December 1985).

Great Britain, Japan, and Canada

Among individual governments that have *not* actively promoted waste reduction are the British and the Japanese. Great Britain has decided to concentrate its efforts on waste management to protect the environment rather than waste reduction. As a member of the European Communities, Britain has endorsed the principal of waste reduction, and the most recent report of the Royal Commission on Environmental Pollution acknowledges its usefulness. However, as the report makes clear, government *action* focuses on achieving higher quality waste management, particularly safe and responsible land disposal.[6] There are no plans in the British Government to promote waste reduction in the foreseeable future.[7]

The Japanese Government, similarly, has not undertaken any dedicated waste reduction actions but has developed and promoted recycling and reuse technologies to address environmental concerns. The Waste Disposal and Public Cleansing Law of 1970 specifically identifies recycling and reuse as the means to reduce wastes in Japan by stating: "The enterpriser must endeavor to lessen the amount of wastes by regeneration or re-use of wastes."[8] The Japanese do have, however, a number of the common indirect incentives to reduce waste such as a tax on air pollutants. They also have a toxic substances control law, which was largely based on the U.S. Toxic Substances Control Act, that provides the government with authority to gather information about and place controls on toxic chemicals in industry and commerce. As is the case in the United States, this law has not been used for waste reduction purposes. In addition, the National Institute of Hygiene has been engaged in research to reduce specific toxics of concern in wastes, for example dioxin.[9]

The Canadian Federal Government has not yet acted in the area of waste reduction but plans to do so in the near future. In Canada, hazardous waste is considered to be a natural resource and therefore is a Provincial responsibility. Among the Provinces, Ontario has been quite active in promoting waste reduction, but little activity has been undertaken elsewhere. However, interest in waste reduction has grown rapidly in Canada and its Federal Government is now becoming involved in a coordinating role. The Canadian Council of Resource and Energy Ministers, a policy-setting group of all Provincial ministers and the Federal minister in this area, plans to meet in October 1986 to discuss an action plan for waste reduction. The contents of this plan were being formulated in mid-1986.[10]

Western Europe

Most of the governments in Western Europe have been promoting the concept of clean technologies (or low- and non-waste technologies) since the 1970s. These European concepts are broader than OTA's concept of waste reduction because they apply to nonhazardous wastes, to product as well as process wastes, and include offsite recycling. In some countries, incineration and other waste treatment methods have been funded as clean technologies. This broader scope of European definitions makes it difficult to analyze the state of waste reduction (in the OTA sense) in these countries. Wherever possible, the extent to which European activities include waste management as well as waste reduction has been noted.

Among individual governments, several have distinctive and interesting approaches to waste reduction. The French have pursued the development of clean technologies primarily to revive productivity and creativity in industry, thereby increasing its international competitiveness. They also hope to be able to turn a profit marketing their technologies in other developed and developing countries. The Dutch, similarly, are promoting research and development of clean technologies, not only to alleviate waste problems at home, but as a potentially profitable export.

In Austria, all new industrial facilities must demonstrate that they employ state-of-the-art low-waste technology before receiving a permit to commence operation. One drawback to this system is that Austrian facilities never need to be repermitted, so older plants are not required to keep up with the latest technologies.[11]

The Norwegians have taken the unique course of regulating by industrial sector, rather than by environmental medium. Thus, the Norwegian environmental regulations are multimedia. This is of particular importance for waste reduction. As discussed elsewhere in this report, waste reduction efforts must be multimedia if they are to avoid shifting of hazardous substances among media.

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[6] Royal Commission on Environmental Pollution, *Managing Waste: Duty of Care*, op. cit., p. 39. Also, Third Action Programme on the Environment, *Official Journal of the European Communities*, Feb. 17, 1983, as cited in the above.

[7] Margot Bellman, British Embassy, Washington, DC, personal communication, May 29, 1986.

[8] Waste Disposal and Public Cleansing Law of 1970, Article 3, Section 2.

[9] Hiro Sato, Deputy Director, Japan External Trade Relations Organization, personal communication, June 9, 1986.

[10] Dave Campbell, Environment Canada, Ottawa, personal communication, May 23, 1986.

[11] OTA meeting with officials from the Austrian Environmental Fund, June 5, 1986.

In the strongly federal West German system, the principal Federal environmental agency, the Umweltbundesamt (UBA), has no regulatory authority. Regulatory authority rests with the States and the Federal UBA acts as a broker and facilitator for waste reduction. Some additional Federal waste reduction action is currently being considered; the proposed Fourth Amendment to the Waste Law of 1972 would require that, where technically feasible, generation of pollution should be avoided and low-waste technologies be used. This provision has already been adopted and implemented in the State of Hesse.

Detailed data, particularly budgetary data, on specific waste reduction programs in these countries are not available in the United States.[12] However, a number of generalizations can be drawn about the type, focus, and duration of clean technologies programs in Western Europe and how they compare with efforts in the United States. First, there as here, waste reduction activities have grown out of pollution control programs. The Environmental Fund in Austria, the Subsidies for Environmental Investment in Denmark, grants and loans from Norway's Pollution Control Authority, subsidies granted under Sweden's Environmental Protection Act, and the West German UBA's R&D grants all began as pollution control assistance programs for industry and now fund waste reduction proposals as well. **However, unlike the United States, some European countries have begun to recognize the unique production orientation of waste reduction and, consequently, to separate waste reduction activities from those classified as pollution control.** Denmark's Clean Technology Office and France's Missions for Clean Technologies are examples.

Most of the European programs concern themselves with pollution in all environmental media. Even the regional agencies regulating France's major river basins have become involved in projects to reduce solid wastes destined for landfills because landfilled wastes may leach into either surface or groundwater.

In addition, European programs usually concern themselves with a broad range of wastes—including what Americans would call both toxic and conventional pollutants—as well as nonhazardous solid wastes. Waste management authorities may have responsibility for only certain subsets of wastes, but agencies specifically directed to promote clean technologies deal with a wide variety of wastes. For example, the French National Agency of the Recovery and Disposal of Waste (ANRED) deals only with solid and RCRA-type hazardous wastes, but the French Mission for Clean Technologies deals with all types of pollution. Similarly, the Danish National Agency for Environmental Protection is divided into a large number of waste-specific units, but the Clean Technology Office researches reduction of all kinds of pollution.

Many European legislatures have empowered their environmental agencies to take mandatory steps to reduce the generation of waste in various ways. These include legislative provisions allowing agencies to restrict the importation, use, and sale of certain hazardous substances or products containing those substances.[13] However, as in the United States, these provisions have been used very little. Instead, **European governments have relied heavily on economic measures. Their efforts have mainly taken the form of grants or loans to fund research on new low-waste technologies and tax incentives and disincentives to influence the actions of hazardous waste generators.** Grant and loan programs for clean technology R&D, which have not been widely used in this country, are a particularly common feature of European waste reduction efforts. Every West European country active in waste reduction has had such a program in place at the national level for at least 5 years. For example:

- Austria's Environmental Fund gives loans and grants for waste reduction and recycling projects;
- Denmark provides grant money under the 1984 amendments to its Act on Recycling, Reuse and Reduction of Waste for projects of those types;
- France's Mission for Clean Technologies provides funding for waste reduction projects. ANRED and the National Agency for Encouragement of Research (ANVARD) under the Ministry of Industry and Research provides funding for a wider variety of waste-related projects;
- France provides rapid depreciation allowances for pollution prevention investments;
- The Netherlands' Committee on Environment and Industry provides R&D grants for clean

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[12] Even if such data were available, the varying scope of the programs as well as varying definitions of "clean technologies" and "low- and non-waste technologies" would make it difficult to separate out the portion of each program which deals with waste reduction as OTA defines it.

[13] See, for example, Denmark's Act on Chemical Substances and Products (1980), France's Waste Law (1975), The Netherland's Chemical Waste Act (1976), Norway's Product Control Law (1977).

technologies. At the same time, waste generation, treatment, storage, and disposal are taxed;
- Norway's Pollution Control Authority provides grants and loans for both clean technologies and pollution control;
- Sweden funds waste reduction projects through grants under its Environmental Protection Act;
- the West German UBA funds both waste reduction and recycling projects.

The fact that these waste reduction programs are often a part of previously existing grant and loan programs for recycling and/or pollution control equipment enables them to use existing bureaucratic frameworks to disseminate funds. OTA was unable to determine if this integration of pollution control and pollution prevention programs was an advantage for waste reduction programs—because it allows them to use existing bureaucratic frameworks to disseminate funds—or a disadvantage—because it puts waste reduction in direct competition with established waste management initiatives for funding and attention.

Dissemination of results of these R&D projects in Europe has been almost entirely passive. Governments have published results in the form of compendia and reports (France, Denmark, Austria, West Germany) and plan to establish low-waste information centers (The Netherlands) and national databases (France) available to industry. Active onsite technical assistance programs of the type used in the State waste reduction programs here (e.g., North Carolina, Minnesota, Pennsylvania, and New York)[14] are rare.

Overall, it appears that governmental interest in waste reduction is growing among industrialized countries and that Western Europeans have the lead in developing and implementing the relevant technologies, in large part because of government involvement. European governments have not relied on regulatory requirements for waste reduction, but have instead used economic measures to encourage waste reduction, particularly grants programs for innovative low-waste projects. These programs have tended to include all types of wastes in all types of environmental media. It is unclear, however, how much success they have had in putting their clean technologies into wide use, and therefore whether government efforts have actually reduced national waste generation or improved industrial productivity.

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[14] See ch. 6.

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